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# US Army Corps of Engineers

Toxic and Hazardous  
Materials Agency

FINAL

**FORT GEORGE G. MEADE  
ACTIVE SANITARY LANDFILL  
AND CLEAN FILL DUMP  
REMEDIAL INVESTIGATION REPORT**

**Prepared for:**

**U.S. Army Toxic and Hazardous Material Agency  
Attn: AMXTH-BC-B (D. Edwards)  
Building 4460  
Edgewood Area  
Aberdeen Proving Ground, Maryland 21010-5401**

**Prepared by:**

**EA Mid-Atlantic Regional Operations  
EA Engineering, Science, and Technology, Inc.  
15 Loveton Circle  
Sparks, Maryland 21152**

**Distribution Unlimited,  
approved for Public Release**

**December 1992**

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Kenneth W. Kilmer  
Director, Engineering Development

26 January 1993  
Date

December 1992



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## EXECUTIVE SUMMARY

EA Engineering, Science and Technology was contracted by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) to conduct a Remedial Investigation at the Fort George G. Meade (FGGM) active Sanitary Landfill (ASL) and a Site Inspection at the inactive Clean Fill Dump (CFD) sites. The objective of the ASL study involved obtaining additional data to evaluate the potential environmental impacts associated with the landfill operations. Prior ASL studies identified low level volatile organic contamination in the water-table aquifer. The CFD study conducted by EA was the initial field investigation at this site. It was performed to assess the need for further environmental study.

Plates 1 and 2, located in the back pocket of this report, are site maps of the ASL and CFD, respectively.

EA conducted a two-phase Remedial Investigation project at the ASL that included collection of surface water, stream sediment, leachate, soil gas, and ground-water samples for analysis. The first phase included installation of twelve shallow monitoring wells and four deep monitoring wells. The second phase included the installation of five shallow monitoring wells and one deep well. The objective of the second well installation phase was to further define the extent of contamination along the southeastern ASL boundary. The analytical data presented in this report were obtained from the analysis of samples collected in March-April 1991.

### Active Sanitary Landfill

The ASL encompasses approximately 130 acres of land and is situated along the FGGM eastern boundary. The ASL was constructed as an unlined facility and is divided into three operational cells (Cells 1, 2, and 3). The ASL accepts sanitary waste generated by the installation. The Enhanced Preliminary Assessment (Argonne 1989) reported that this facility has accepted petroleum waste, contaminated soil excavated from underground storage tank sites, and pesticides. As part of the Fort George G. Meade Underground Storage Tank (UST) program, the soil that was excavated for UST sites was aerated at the active sanitary landfill and then used for daily cover. This activity was approved by the Maryland Department of Environment at that time, however, this practice has been discontinued.

The surrounding land to the east and southeast of the ASL is privately owned. The ASL and adjacent property to the north, west, and south of the site is to be retained by FGGM and is not included in the 7,600-acre transfer to the Patuxent Wildlife Research Center.



The site is underlain by the Potomac Group. The Potomac Group has been subdivided into the Patapsco, Arundel, and Patuxent formations. In this area, the Patapsco Formation can be divided into the upper and lower Patapsco aquifers and a middle confining layer. Field drilling revealed that this confining layer is continuous across the site.

The Upper Patapsco Formation acts as the water-table aquifer. This unit is hydraulically separate from the Lower Patapsco Formation, which is the uppermost confined aquifer at the site. There is a downward vertical gradient between the shallow and deep wells.

The direction of ground-water flow in the central and northern regions of the site is to the west. The ground-water flow direction along the southern and eastern landfill boundaries is to the south and southeast, respectively. The southerly flow direction off the southern and eastern ASL boundaries is consistent with the regional flow patterns.

The water supply well survey did not identify any domestic use of the water-table aquifer southeast of the ASL. It is possible, however, that there are pre-1969 wells in use to the southeast of the ASL along Patuxent Road.

The data from the surficial soil, surface water, and stream sediment samples did not reveal any contaminants at levels of concern.

The monitoring well network was designed to monitor water quality in both the water-table aquifer and the uppermost confined (lower Patapsco) aquifer. The data confirmed that the landfill is a source of low level volatile organic contamination in the water-table aquifer, with volatile organic compounds detected in 17 of the 20 samples. The samples with the highest volatile organic levels were located immediately downgradient of the ASL on the western boundary. These data show that the extent of contamination to the west, south, and southeast of the ASL has not been fully defined.

In comparing the data to the regulatory criteria [Maximum Contaminant Level (MCL) or Maximum Contaminant Level Goal (MCLG)], benzene was the only volatile organic compound that exceeded these criteria. The MCL for benzene is 5  $\mu\text{g/L}$  and the MCLG is 0  $\mu\text{g/L}$ . These values were exceeded in four wells: MW-9 (6.59  $\mu\text{g/L}$ ), MW-12S (6.43  $\mu\text{g/L}$ ), MW-16 (5.43  $\mu\text{g/L}$ ), and MW-19 (12.4  $\mu\text{g/L}$ ). MW-19 is located adjacent to the southeastern ASL and FGGM boundary.

There were no volatile organic compounds detected in the six lower Patapsco wells. Metals concentrations found in the samples from the lower Patapsco wells are not a concern. Low levels of pesticides were detected in all of the samples. Uncertainty exists regarding the validity of these data.



The concentration levels were very low but the occurrences were persistent, leading to uncertainty in the interpretation of these results. There were no co-contaminants detected in these samples, furthering the level of uncertainty with regard to potential sources.

Analytical results obtained from the leachate samples showed volatile organic contamination similar to the water-table aquifer data.

The soil gas samples were analyzed for methane, aromatic hydrocarbons, and chlorinated hydrocarbons. Elevated methane concentrations were located along the southern and northern boundaries. Highest levels of hydrocarbon contamination were located in the northern area of Cell 1.

The contaminant migration route of concern is the ground-water flow regime in the water-table aquifer. The primary environmental concern is the volatile organic contamination. This route of migration was evaluated through the use of two ground-water models.

The model results show that contaminant movement in the water-table aquifer from the central region of the landfill and along the western boundary occurs in a westerly direction consistent with the surface stream flow direction along the western boundary. The model results also show that along the southeast boundary the contaminants are projected to migrate in a southeast direction across the FGGM boundary with the plume potentially extending as far east as Patuxent Road.

The primary pathway for exposure in the vicinity of the ASL is from the ingestion of ground water from both the water-table and confined aquifers potentially affected by the ASL. This process involved evaluating the risk potential relative to average and reasonable maximal exposure (RME) for both carcinogenic and noncarcinogenic effects. Although there is no onsite use of this aquifer, there is a limited potential that residents located southeast of the ASL along Patuxent Road are consuming water from this aquifer.

While the noncarcinogenic risk for consumption of ground water from the upper Patapsco aquifer under average exposure conditions is negligible, the RME scenario resulted in noncarcinogenic risk greater than the acceptable level. Carcinogenic risk for this aquifer was marginally acceptable for the average exposure, but unacceptable for the RME.

Noncarcinogenic risk from consuming water from the lower Patapsco aquifer was acceptable under the average or RME exposure.

Carcinogenic risk associated with consuming water from the confined aquifer

under the average exposure was acceptable. However, the RME exposure yielded an unacceptable cancer risk.

#### Clean Fill Dump

A two-phase study was conducted at this site concurrently with the ASL study. The first phase included the installation of five monitoring wells. The results of this phase included the detection of two volatile organic compounds in one of the ground-water samples collected from these initial wells. The levels of one of these compounds exceeded the MCL. The second phase of this study included the installation of one additional monitoring well.

The CFD is an inactive, unlined facility that was designed to accept inert material from the installation. It is located along the eastern boundary of FGGM in a lowland area. The CFD has been covered by soil and revegetated with grass. The CFD is included within the 7,600 acres that was transferred to the Patuxent Wildlife Research Center on 16 October 1991. Since disposal of waste was not controlled, waste other than inert material may have also been disposed of at the site. Waste material was also placed in an area of uncontrolled surface dumping located adjacent to the CFD along Boundary Road.

The site is surrounded by wooded areas on the north, west, and east and by a low-lying marshy area adjacent to the southern boundary. The subsurface materials consist of Patuxent River terrace deposits and alluvium material overlying the Potomac Group sedimentary deposits. These deposits consisted primarily of clayey sand and silt with interbedded layers of sand and gravel.

The field investigation conducted at the CFD was designed to evaluate the ground-water quality and movement in the water-table aquifer. The direction of ground-water flow at this site is to the south toward the marshy area. The site is located in a ground-water discharge area.

One ground-water sample (from well CFD-3S) exhibited elevated levels of trichloroethene (TCE) (7.25  $\mu\text{g/L}$ ) and tetrachloroethene (PCE) (56.0  $\mu\text{g/L}$ ). The TCE level exceeds the final MCL (5  $\mu\text{g/L}$ ) and the PCE level exceeds the proposed MCL (5  $\mu\text{g/L}$ ). These compounds were not detected in the ground-water sample collected from CFD-3D, the deep well located next to the shallow CFD-3S well.

Low levels of pesticides were detected in four of the six samples. None of these levels exceeded regulatory criteria. The presence of these low levels of pesticides is a minor concern.

A few total arsenic, chromium, and lead values exceeded regulatory criteria;



however, dissolved metals values for ground-water samples were below regulatory criteria.

There were no volatile or semivolatile organic compounds detected in the surface water or stream sediments. Low levels of pesticides were detected in the surface water and sediments.

Volatile organic compounds and metals values reported in the ground water are the compounds of concern at this site. Ingestion of ground water was evaluated as a potential exposure scenario.

The risk assessment concluded that consumption of ground water was unacceptable for both noncarcinogenic and carcinogenic effects under the average and the RME scenarios.

The ground-water exposure pathway is limited by the vertical upward ground-water gradient at the site, which induces discharge of ground water to surface water. This provides no transport mechanism for contaminants to migrate within the ground water.

Based on the conclusions presented, the following recommendations were developed.

#### Active Sanitary Landfill

1. Conduct a water supply well survey along Patuxent Road to collect information on ground-water use and identify potential receptors of concern.
2. Install four shallow monitoring wells and two monitoring well clusters outside the existing well network to more fully define the extent of contamination. Two of the shallow wells should be placed to the west of the confluence of the surface streams in the ammunition supply point area. The other two shallow wells should be located southwest and south of the ASL. The well clusters should be installed southeast of the ASL beyond the reservation boundary to the east of the Amtrak rail lines. The proposed construction and location of these well clusters should be modified by the information obtained from the well survey.



3. Following installation of these additional wells, conduct a complete sampling event that includes surface water, leachate, and ground water. Samples should be analyzed for TCL/TAL parameters and indicator parameters such as chloride, nitrate, total dissolved solids, sulfate, and turbidity.
4. Perform surficial soil sampling to create an expanded database. A total of 20 additional samples should be collected and analyzed for TCL/TAL parameters plus cyanide. Three samples should be taken to provide data for a site-specific background. The 17 onsite samples should be taken from a spatial grid developed for the ASL.

#### Clean Fill Dump

1. Annual ground-water and surface water sampling for the next 5 years is recommended to expand the database and monitor water quality. There is no need for additional wells at this site. Two surface water sampling stations should be located closer to the site and included in the monitoring program. One of these stations should be located in proximity to the CFD-3 well cluster.

## 1. INTRODUCTION

### 1.1 PROJECT BACKGROUND

EA Engineering, Science, and Technology conducted two environmental studies at Fort George G. Meade (FGGM) for the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA). These studies consisted of a Remedial Investigation (RI) at the Active Sanitary Landfill (ASL) and a Site Inspection (SI) at the inactive Clean Fill Dump (CFD). The results of these studies are presented in this report.

#### 1.1.1 Active Sanitary Landfill

The RI field work was initiated in 1989 and consisted of an electromagnetic (EM) survey and a Phase I sampling event that included existing wells, leachate seeps, surface water, and stream sediment samples. These activities were followed by EA's initial well installation phase that included completion of twelve monitoring wells in the water-table aquifer and five wells in the uppermost confined aquifer. The five deep wells were each coupled with a shallow well to form a two-well cluster monitoring the water-table and uppermost confined aquifer.

Phase II sampling included collection of soil samples from the five deep borings for permeability testing, ground-water sample collection from the new wells, an ecological survey, slug tests, and field surveying. A draft RI report presenting the findings of the initial phases was completed in April 1990 and submitted to USATHAMA. The analytical data collected during Phase I and Phase II were deemed unacceptable because of quality assurance problems at the laboratory in the timeframe that this project work was completed. In 1991, USATHAMA directed EA not to use any of the data generated by this laboratory in any future reports or presentations.

The conclusions from the draft report indicated that the landfill was the source of low level volatile organic contamination in the water-table aquifer. The extent of this contamination was reasonably confined to the vicinity of the site except for the southeastern landfill boundary, which coincides with the FGGM property boundary. Prior to determining whether monitoring wells should be installed offsite, additional onsite monitoring wells were recommended to provide further information on ground-water quality and flow patterns in this area.

In 1990, five shallow and one deep monitoring well were installed by EA in 1990 primarily to the east and southeast of the landfill within the FGGM property boundary. Ground-water and leachate samples were collected in

1990; however, a USATHAMA quality assurance audit of the laboratory conducting the analyses determined that the data did not meet the data quality objectives of the task and therefore was not usable.

In March-April 1991, a resampling effort was completed and included collection of ground water, leachate seep, surface water, and stream sediment samples. These data were utilized in the preparation of this report.

#### 1.1.2 Clean Fill Dump

The Phase I study conducted by EA at the CFD was an initial study that included field data collection and was completed concurrently with the Phase I field work at the ASL. The initial field work consisted of installing five monitoring wells, collecting ground water and surface water samples, conducting slug tests, and field surveying. The results from this work indicated that there was limited contamination in the water-table aquifer that was associated with the CFD. This work was followed by the installation of a deeper well located next to the contaminated well to gather additional information.

The analytical work that was performed to address this site was affected by the same set of circumstances that were outlined in the previous section. Therefore, the March-April 1991 data set was the only data set utilized in the preparation of this report. This data set included analysis of ground water, surface water, and stream sediment samples.



## 1.2 SITE BACKGROUND

### 1.2.1 Site Description and History

Figure 1.2-1 shows the regional location of FGGM between Baltimore, Maryland, and Washington, D.C. Both of these sites are located along the eastern boundary of FGGM and were originally included in the 9,000 acres designated for Base Realignment and Closure (BRAC) (Figure 1.2-2). In 1991, an agreement was reached between the U.S. Army and the Patuxent Wildlife Research Center to transfer 7,600 acres of the 9,000 acres to the Patuxent Wildlife Research Center. This transfer took place on 16 October 1991. The 7,600 acres that was transferred consisted of the firing range and training areas. The Tipton Army Airfield is not included in this 7,600-acre parcel and is also proposed to be released by the Army as part of the BRAC. The sanitary landfill and surrounding area have been exempted from closure and will be retained by the U.S. Army. The CFD was specifically excluded from the 7,600 acres that have been transferred to the Patuxent Wildlife Research Center. The transfer agreement stipulates that the U.S. Army will retain responsibility for monitoring the site until it is not considered a potential threat to the environment. If this monitoring provides evidence that remediation is necessary, the U.S. Army will be responsible for this activity. The CFD will be included in the transfer after it is determined to be "environmentally clean."

FGGM is a permanent U.S. Army installation and presently occupies approximately 4,000 acres in the northwest corner of Anne Arundel County, Maryland. The installation contains administrative, recreational, and housing facilities, and limited training areas and firing/combat ranges. The FGGM community consists of a residential population and daytime work force of approximately 20,000.

Previous investigations have been conducted at the ASL involving installation of four monitoring wells for collection of ground-water samples. Analytical results from these samples indicated that volatile organic contamination was detected in one well. Additionally, some indicator ground-water parameters (conductivity, pH, chloride, and alkalinity) have shown an increasing trend over the past few years. The evaluation of these factors indicated a need for conducting additional work at the site that initiated this RI study.

The ASL is an unlined facility that occupies approximately 130 acres along the eastern boundary of the military reservation. The surrounding land use consists of an ammunition bunker supply area to the west, firing ranges to the south, the Town of Odenton and an offpost trailer park to the east, and



Meadedale, a small post community to the north. Amtrak and Baltimore & Ohio rail lines are found along the eastern boundary of the ASL.

This landfill was opened in 1958 and operated utilizing the trench-fill method until 1976. At that time, the trench-fill method had consumed all of the landfill area, and the area-fill method was initiated. Refuse disposed in the landfill reportedly consists of mixed residential, commercial, and nonhazardous industrial wastes. As part of the FGGM underground storage tank (UST) program, the soil that was excavated from UST sites was aerated at the ASL and then used for daily cover. This activity was approved by MDE at the time; however, this practice has been discontinued. This tank program has been in existence for the last 3 to 5 years.

The landfill is divided into three cells. The permitted landfill area and approximate cell divisions are shown in Figure 1.2-3. The Cell 1 dimensions shown in this figure are not consistent along the northern and western Cell 1 boundaries. The area to the west of the current Cell 1 boundary is marshy and not suitable for waste disposal. The present conditions also show that Cell 1 was extended to the north across an intermittent stream channel that carried stormwater runoff from east to west. Review of topographic maps and information provided by landfill operating personnel indicated that two 10-ft lifts have been placed on the trench-fill area in Cell 1. Cell 2 is the active fill area; two 10-ft lifts cover approximately 50 percent of Cell 2, with the placement of fill progressing from east to west. In Cell 3, no additional lifts have been placed above the trench-fill material.

The CFD was operated from 1972 to 1985 in a modified area method. The landfill study conducted by the U.S. Army Environmental Hygiene Agency (USAEHA) stated that the CFD was to accept waste that consisted of combustible and noncombustible material, such as stumps, trees, old appliances, and fill dirt. This report also noted that many of the excluded types of waste (garbage, food waste, cans, bottles, ashes, and other putrescible matter) had been observed at the CFD, which is located in a less developed area of the installation. It is surrounded by wooded areas on the north, south, and east, and by a low-lying marshy area to the west.

#### 1.2.2 Regional Physiography

FGGM is located within the Coastal Plain physiographic province. The topography of the area (Figure 1.2-4) is marked by rolling uplands dissected by low-gradient streams that generally flow in a southerly direction toward the broad, flat river valley of the Little Patuxent River. The land surface elevation within the study area ranges from a high point of approximately 180 ft above mean sea level (MSL) along the eastern and southern boundaries

of the ASL to a low point of approximately 80 ft above MSL, south of the CFD. Surface runoff is ultimately directed toward the Little Patuxent River, located to the south of the study areas, via small unnamed streams. The Little Patuxent River flows to the southeast and is a major tributary of the Patuxent River.

### 1.2.3 Regional Geology

FGGM is located just east of the Fall Line, the boundary between the Coastal Plain and Piedmont physiographic provinces. The Coastal Plain is underlain by a wedge-shaped mass of unconsolidated sedimentary deposits, which overlie much older consolidated rock. The outcrop belt of the Potomac Group of Lower Cretaceous age occupies nearly the entire northern third of Anne Arundel County. The Potomac Group comprises the entire thickness of the Coastal Plain sediment in the northern part of the county.

The stratigraphy of the Potomac Group is complex. The Potomac Group is approximately 600+ ft thick in the study area, and its component formations from oldest to youngest are the Patuxent, Arundel, and Patapsco. Because formations of the Group were deposited under fluvial and lacustrine conditions, sand, silt, and clay layers are commonly intermixed and limited in lateral extent (Mack and Achmad 1986). The type of depositional environment, including the occurrence of lenticular bedding and vertical repetition of essentially similar units, has made division of mappable units within the Potomac Group a subject of continued debate.

Figure 1.2-5 is a geologic map of the FGGM area. On this map the Potomac Group is divided into a sand-gravel facies and a silt-clay facies. The ASL is located in the sand-gravel facies outcrop area with the silt-clay facies outcropping to the west, south, and east of the permitted landfill area. The CFD is located in the outcrop area of Patuxent River Terrace deposits.

Figure 1.2-6 shows a geologic cross section and the stratigraphic sequence in the FGGM area. Table 1.2-1 provides additional stratigraphic, hydrologic, and lithologic characteristics of the geologic formations in the FGGM and Anne Arundel County area.

### 1.2.4 Regional Hydrogeology

Recent studies (Mack and Achmad 1986) have shown that the Potomac Group is comprised of three separate and distinct aquifers in Anne Arundel County. These aquifers are known locally as the upper and lower Patapsco aquifers in the Patapsco Formation, and the underlying Patuxent aquifer. These aquifers are confined, except in their outcrop areas where they exist under



water-table conditions. Two distinct confining beds consisting of silt-clay facies separate the three aquifers.

The confining layer that separates the lower Patapsco from the Patuxent aquifer is the Arundel Formation. The Arundel Formation is, on average, 250 ft thick and consists of red, brown, and gray clay with some ironstone nodules. The confining bed separating the lower and upper Patapsco aquifers has not been named and will be referred to in this report as the "middle confining layer." Regionally, this middle confining layer is approximately 125 ft thick and consists of massive beds of clay of low vertical hydraulic conductivity. There are, however, layers within this confining unit that are relatively permeable. Glaser (1976) recognized two lithologic units in the Potomac Group: a sand-gravel facies and a silt-clay facies. The sand-gravel facies encompasses the upper Patapsco aquifer, whereas the silt-clay facies includes the middle confining layer.

The ASL is located within the outcrop area of the upper Patapsco aquifer. The middle confining layer between the lower and upper Patapsco crops out just west of the landfill area.

Quaternary deposits, consisting of Patuxent River terraces, crop out on the top of the ridge in the vicinity of the CFD. These terraces are composed of interbedded sand and gravel with lesser amounts of silt and clay. These deposits vary considerably in thickness, with the average thickness being 25 ft. The Little Patuxent River is near the west and southwest boundaries of the CFD. The area between the CFD and the Little Patuxent River is covered with alluvial deposits, and a large percentage of this area consists of marsh land. These marsh land deposits are composed of interbedded silt, clay, and sand with organic matter as a common component.

The saturated sand and gravel strata of the Potomac Group provide a source of water for domestic, industrial, and municipal supplies in Anne Arundel County.

The upper Patapsco aquifer comprises the water-table aquifer in the study area, whereas the lower Patapsco and Patuxent aquifers are under confined conditions. The available literature indicates that transmissivity values obtained from pump test data for the Patuxent aquifer range from 80 to 9,000 ft<sup>2</sup>/day; for the lower Patapsco aquifer, from 900 to 6,000 ft<sup>2</sup>/day; and for the upper Patapsco aquifer, from 100 to 10,000 ft<sup>2</sup>/day (Mack and Achmad 1986). The average vertical hydraulic conductivities for the unnamed confining bed separating the upper and lower Patapsco aquifers and the Arundel clay, which overlies the Patuxent aquifer, are reported to be  $1.0 \times 10^{-5}$  and  $5.9 \times 10^{-7}$  ft/day ( $3.0 \times 10^{-9}$  and  $2.08 \times 10^{-10}$  cm/sec), respectively (Mack and Achmad 1986). Ground-water gradient for the water-table aquifer is controlled



by topography, which trends to the east, west, and south at the ASL and to the south at the CFD. The regional hydraulic gradient in the confined aquifers generally trends to the southeast, consistent with the dip of the formations.

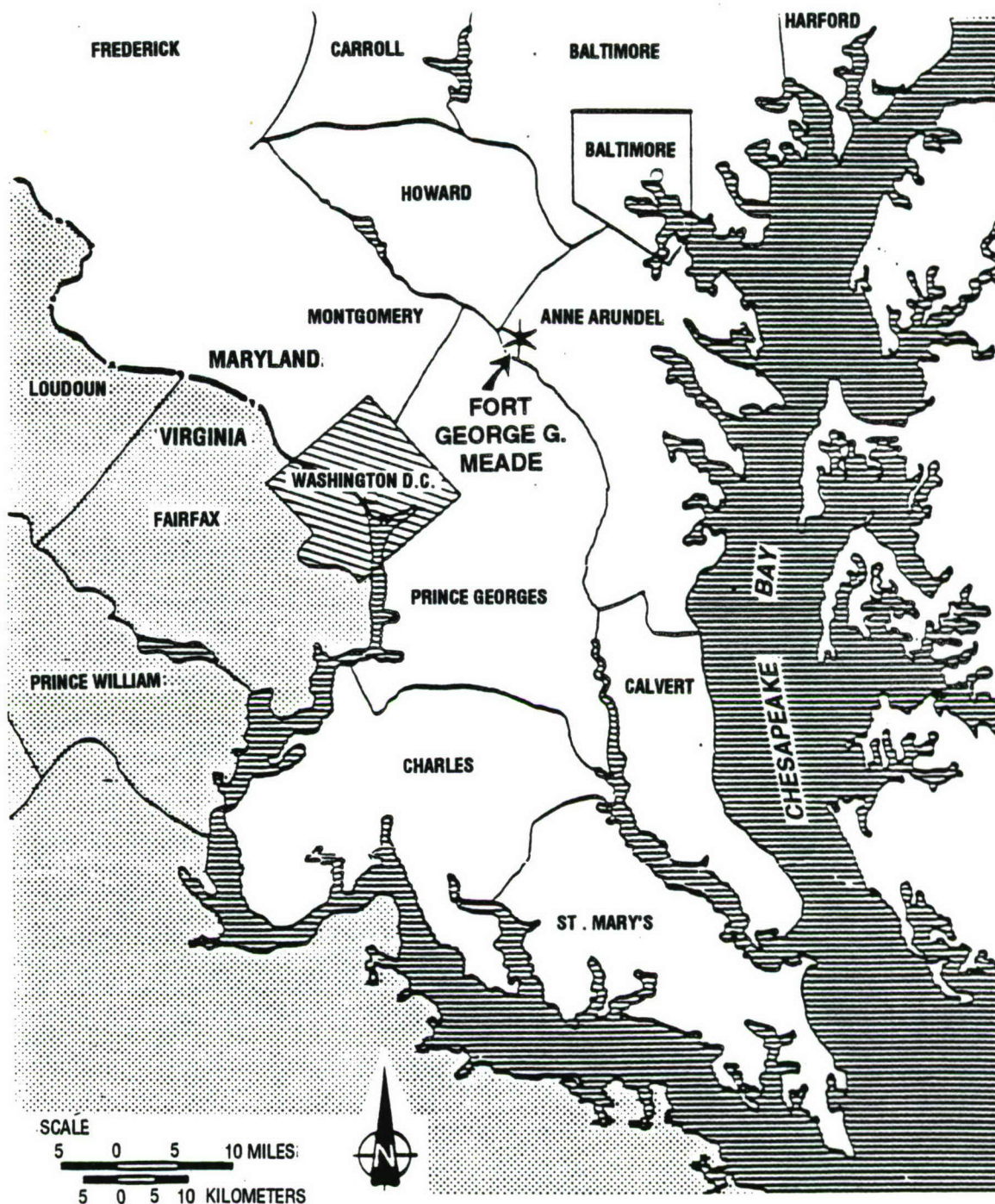


Figure 1.2-1. Fort Meade regional location map.







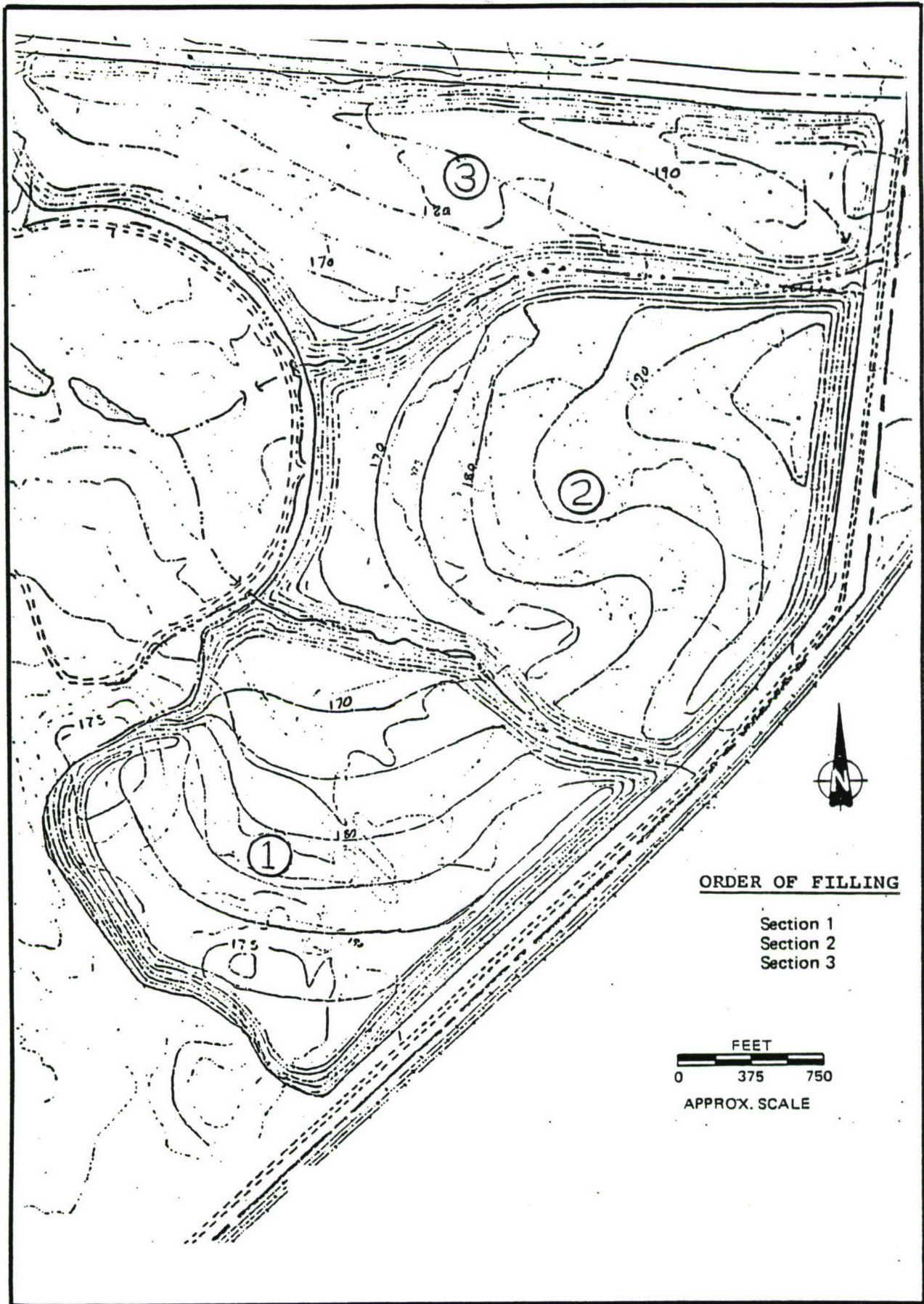


Figure 1.2-3. FGGM Sanitary Landfill cell divisions.



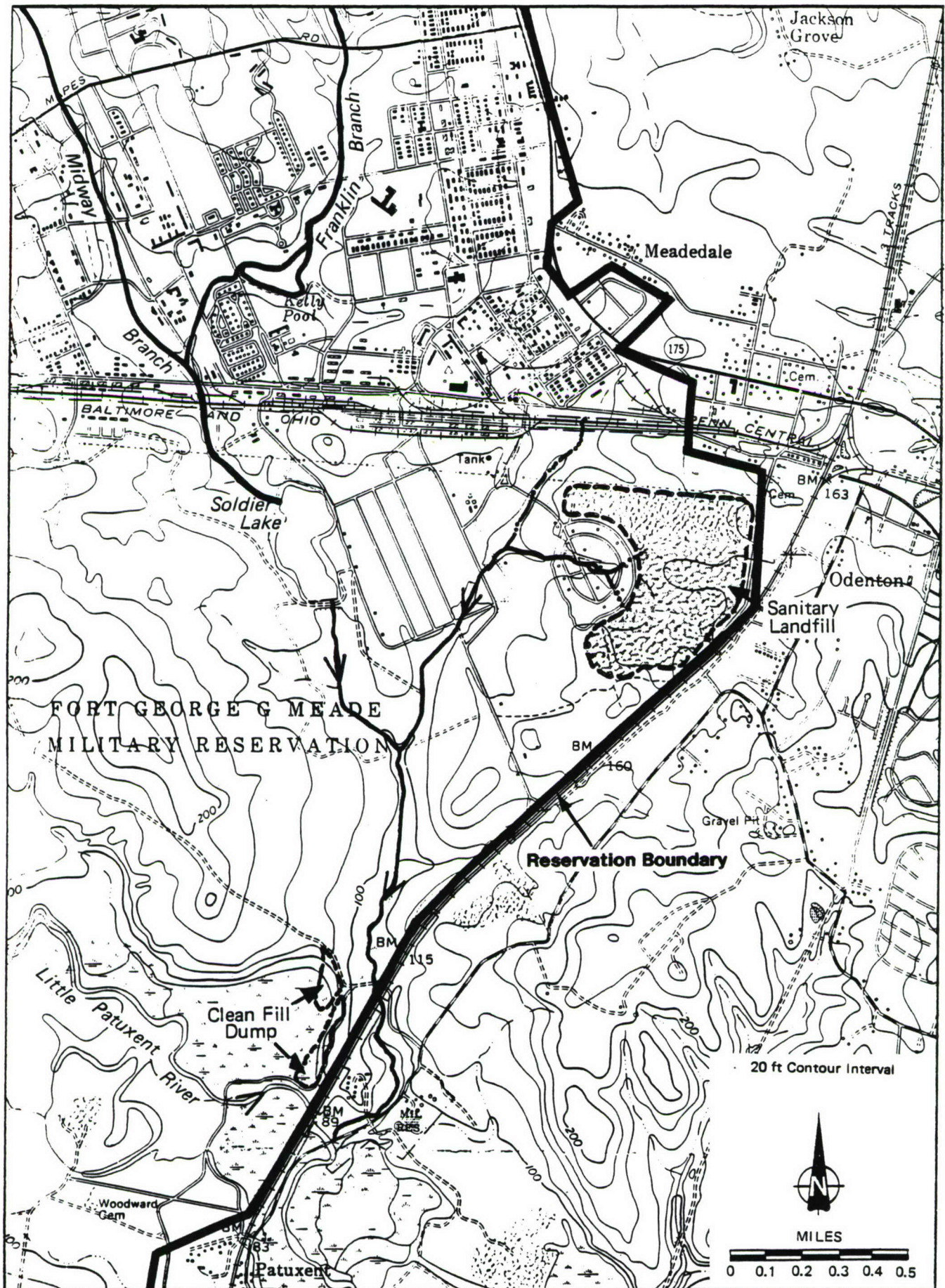
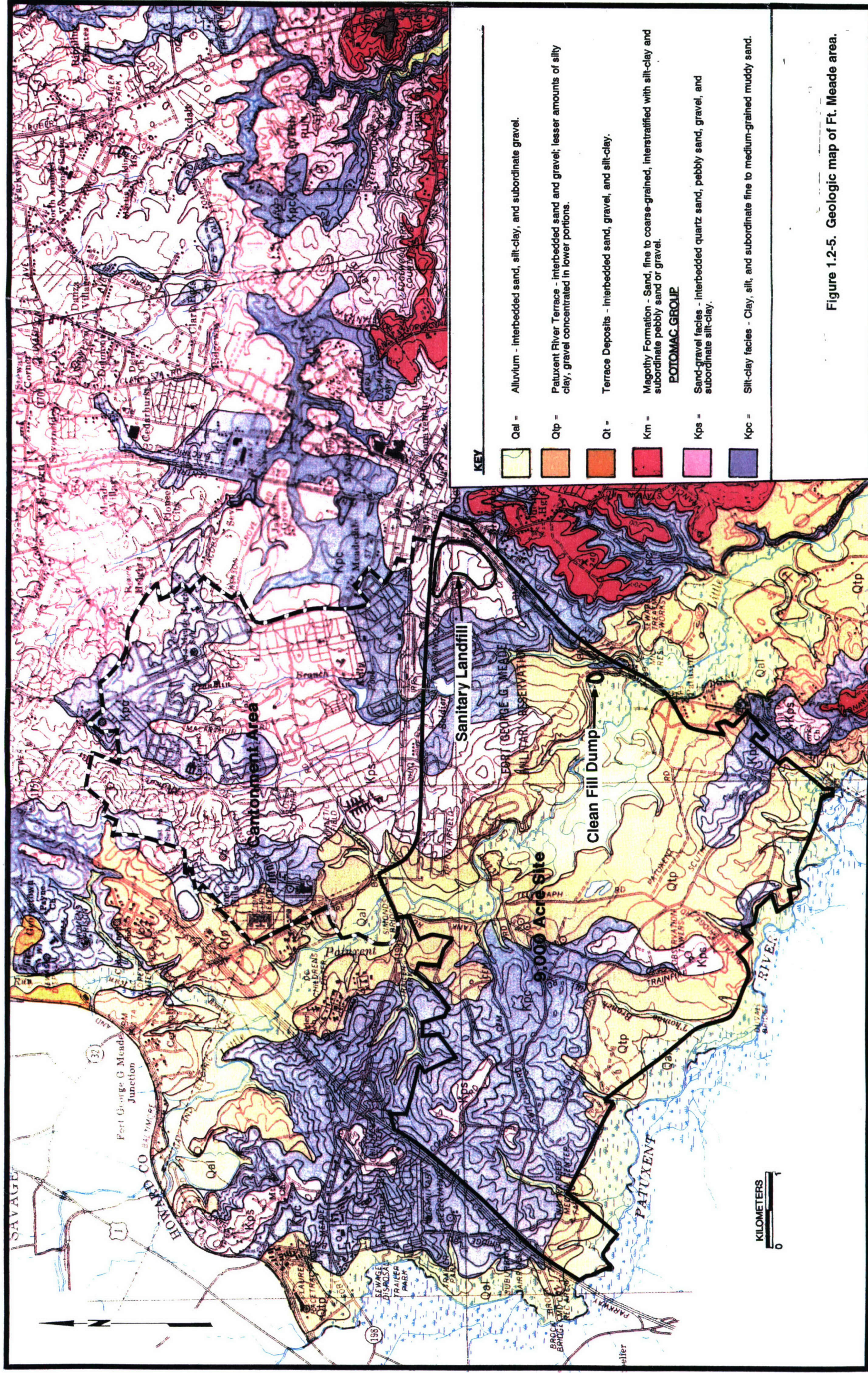


Figure 1.2-4. Topography of FGGM Sanitary Landfill and Clean Fill Dump areas.  
(Source: U.S.G.S. Odenton Quadrangle)





**Figure 1.2-5. Geologic map of Ft. Meade area.**



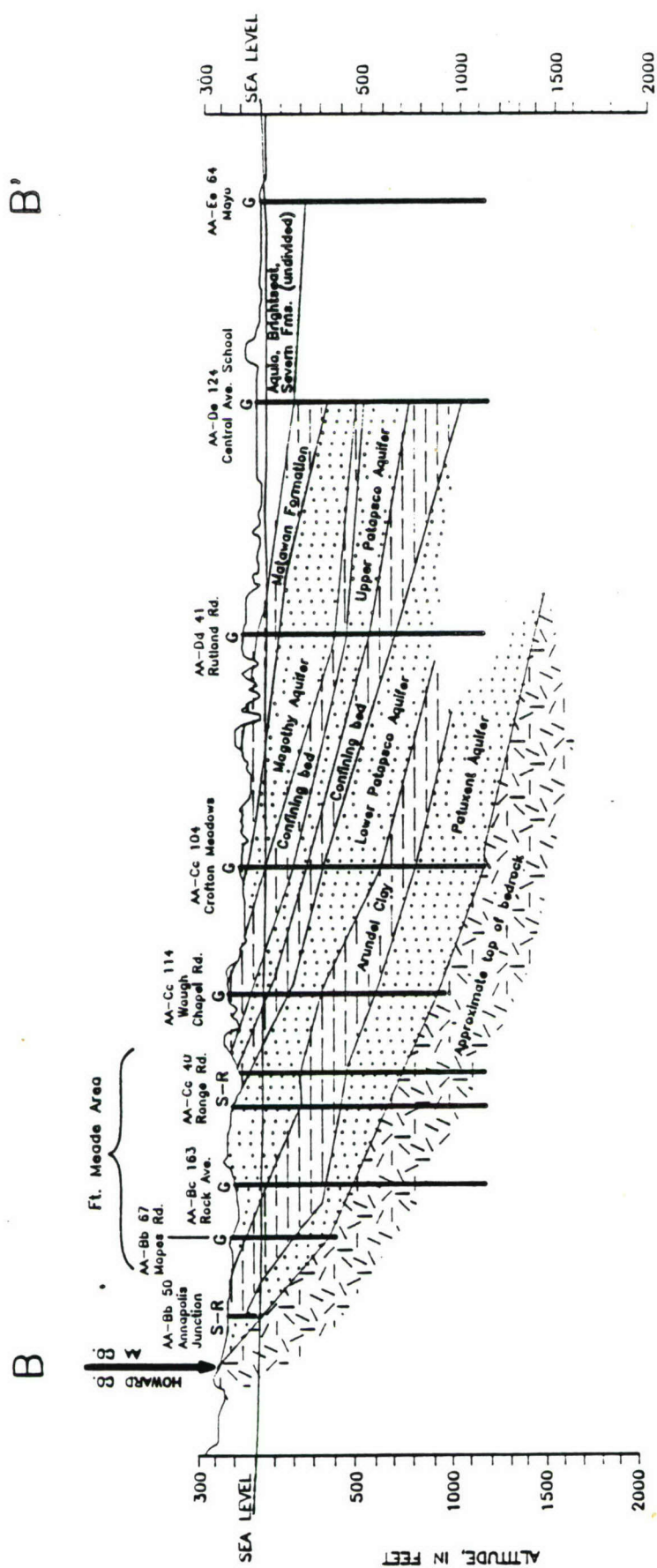


Figure 1.2-6. Geologic Cross Section.

**TABLE 1.2-1. STRATIGRAPHIC AND LITHOLOGIC CHARACTERISTICS  
OF GEOLOGIC FORMATIONS IN ANNE ARUNDEL COUNTY**

System	Series	Group	Formation	Average thickness (feet)	Lithologic symbol	Hydrologic character	General lithology	
QUATERNARY	HOLOCENE and PLEISTOCENE		Alluvium and terrace deposits	30		Confining bed in most places. Poor aquifer in some places.	Sand, gravel, silt, and clay.	
TERTIARY	EOCENE	PAMUNKEY	Nemomey Formation	80		Confining bed	Sand, with clayey layers, glauconitic.	
	Maribers Clay		30		Confining bed	Clay, plastic, pale-red to silvery gray.		
	PALEOCENE		Aquia Formation	100		Aquifer	Glauconitic, greenish to brown sand with indurated or "rock" layers in middle and basal parts.	
			Brightseat Formation	40		Confining bed in most places. Poor aquifer in some places.	Sand, silt, and clay, olive gray to black, glauconitic.	
CRETACEOUS	UPPER  CRETACEOUS		Severn Formation	90		Poor aquifer in places.	Sand, silty to fine, with some glauconite.	
			Metcuen Formation	30		Confining bed	Silt and fine sand, clayey, dark gray to black, glauconitic.	
			Megalloway Formation	100		Aquifer	Sand, light gray to white, with interbedded thin layers of organic black clay.	
	LOWER  CRETACEOUS	POTOMAC	Potapco formation	Upper part	75		Confining bed	Clay, tough, variegated color.
						Aquifer	Sand, fine to medium, brown color.	
				Lower part	250		Confining bed	Clay, tough, variegated color.
						Aquifer	Sand, fine to medium, brown color.	
			Arundel Clay	250 (?)		Confining bed	Clay, red, brown, and gray, contains some ironstone nodules and plant remains.	
			Ponca Formation	250 (?)		Aquifer ?	Sand, gray and yellow, with interbedded clay; well-sorted, rounded, and light-colored.	
						Aquifer ?	Locally clay layers predominate.	
	LOWER PALEOZOIC (?) TO PRECAMBRIAN(?)			Basement Complex	Unknown		Confining bed	Probably gneiss, granite, gabbro, meta-gabbro, quartz diorite and granitized schist.

## 2. SANITARY LANDFILL

### 2.1 OBJECTIVES AND SCOPE OF WORK

The overall objective of the RI process is to collect data to characterize site conditions, define the nature and extent of contamination, and assess the risk to human health and the environment. The ultimate goal of the RI project phase(s) is to collect sufficient data to conduct a Feasibility Study (FS), which serves as the mechanism for the development and evaluation of remedial alternatives, if needed.

The scope of work for this RI study was designed to acquire information to assess the environmental impact of the ASL. The scope was developed by evaluating the existing data and existing monitoring points, and by reviewing the site history and conditions. The following is an outline of the field activities conducted at the sanitary landfill. Plate 1 (back pocket) is a detailed site map showing sample locations.

1. An EM conductivity survey was conducted around the perimeter of the ASL to assist in monitoring well placement.
2. Five test borings were drilled and sampled at 5-ft intervals for stratigraphic control. One Shelby tube sample was collected for permeability testing from each test boring advanced through the middle confining layer.
3. Phase I Well Installation--Five deep and twelve shallow wells were installed around the ASL. Ground-water samples were collected for chemical analysis from each well. Each of the five deep wells was installed near a new or previously existing shallow monitoring well to form a two-well cluster. The shallow wells were screened in the upper Patapsco (water-table) aquifer and the deep wells were screened in the lower Patapsco aquifer.
4. Phase II Well Installation--Five shallow monitoring wells and one deep monitoring well were installed to supplement the existing wells and Phase I wells.
5. Ground-water levels were obtained at all wells.
6. Slug tests were conducted on selected shallow and deep wells to calculate hydraulic conductivity.



7. A field survey was conducted to determine horizontal location within  $\pm 3$  ft and vertical elevation within  $\pm 0.05$  ft on EA monitoring wells and sampling points.
8. Aerial photogrammetry was utilized to produce site topographic maps at a 1 in. = 100 ft scale and 2-ft contour interval.
9. An ecological survey was conducted to characterize the terrestrial and aquatic resources and to assess whether these resources have been affected by the ASL.
10. A soil gas survey was conducted to evaluate landfill gas migration at the ASL.
11. Three surficial soil samples were collected for analysis and use in the health risk assessment.
12. Six surface water and sediment samples were collected for chemical analysis from streams in the vicinity of the ASL.
13. Ground-water samples were collected from all existing, Phase I, and Phase II wells for monitoring of ground-water quality.
14. Three leachate samples were collected for chemical analysis from seeps located around the ASL.

## 2.2. PHYSICAL CHARACTERIZATION

### 2.2.1 Site Geology

The field investigation conducted during this study confirmed that the Potomac Group outcrops in the vicinity of the ASL. As stated previously, the geology of the study area consists of the Patapsco, Arundel, and Patuxent formations, which comprise the Potomac Group, with an approximate total thickness of 600 ft in the FGGM area. Six deep borings and seventeen shallow borings were drilled at the site and completed as monitoring wells. Geologic cross sections A-A' and B-B' were constructed from soil boring data obtained during this study (Figures 2.2-1 and 2.2-2). The boring/well locations used to complete the cross sections are shown in Plate 1. EA boring logs and well construction diagrams are included in Appendix C.

Data from the borings indicate that the thickness of the upper Patapsco aquifer ranges from 5 to 10 ft west of the landfill and from 30 to 40 ft along the eastern ASL boundary. Texturally, the upper Patapsco aquifer is variable, but typically consists of yellowish-brown to grayish orange, fine to medium grained sand to silty sand. Intercalated thin beds of clay and gravel were encountered, but rarely.

Underlying the upper Patapsco aquifer is the middle confining layer, a thick, hard, highly plastic, mottled, dark reddish-brown to light gray clay. A dark gray clay layer with intercalated black coal seams was encountered in the lower portions of this clay unit. Most shallow monitoring well borings located west of the landfill encountered the top of this clay unit.

Six deep test borings were drilled through the middle confining layer to install monitoring wells in the underlying lower Patapsco aquifer. Data from these borings indicate that the top of the middle confining layer is present at depths ranging from approximately 8 ft along the western boundary of the landfill to 40 ft below grade along the eastern boundary. The thickness of this middle confining layer ranges up to 96 ft (in the test boring for MW-10D) with an average thickness of 50 ft across the site. This layer generally slopes to the southeast, consistent with the regional geologic structure. Correlation of a 25-ft-thick clay unit in MW-2D with this middle confining layer is uncertain (Figure 2.2-2).

The lower Patapsco aquifer consists of a light gray to grayish orange, fine to medium silty sand grading downward into a medium to coarse sand with minor silt. Deep test borings encountered the top of the unit at elevations on the order of 45 ft above MSL and penetrated approximately 15 to 25 ft of



this aquifer. The aquifer is reported to range in thickness from 80 to 100 ft in the local area and overlies the Arundel Formation (Mack and Achmad 1986).

### 2.2.2 Hydrology

The ASL is situated on a broad upland within the Little Patuxent River watershed. The central and northern regions of the site slope gently to the west, and surface water runoff from this area is directed to the west. A limited area along the northern boundary of the permitted area slopes and drains to the northwest.

Prior to landfill construction, two intermittent surface streams flowed from east to west across the landfill site, according to topographic maps. The flow of the southernmost intermittent stream across the landfill site has been altered by the northern extension of Cell 1. In addition, the construction of the Amtrak railroad yard and an electrical contracting company facility along the eastern FGGM boundary has influenced surface water runoff along the eastern boundary of the ASL. The surface water runoff that used to flow from east to west across the landfill site now is either stagnating along the eastern FGGM boundary or is flowing in a southerly direction via surface water drainage channels on the Amtrak property. These surface water drainage channels discharge into an intermittent stream that flows in a southwest direction onto the FGGM property south of the landfill. According to FGGM personnel, there are ongoing discussions to resolve the handling of the ponded surface water and stormwater runoff in this area.

Two perennial streams are present along the western landfill boundary and flow from east to west. Surface water runoff from the central and northern regions of the landfill is discharged into these stream channels. These two streams merge just west of the landfill and flow into two small ponds in the inactive ammunition supply bunker area. The ponds discharge into a wetland area, which drains into an unnamed tributary to the Little Patuxent River. This tributary flows in a southerly direction to the Little Patuxent River.

### 2.2.3 Hydrogeology

Unconfined (water-table) and confined ground-water conditions both exist underneath the site. The water-table aquifer consists of the Upper Patapsco Formation, while confined ground-water conditions exist in the Lower Patapsco Formation. These two aquifers are separated by a middle confining layer, averaging 50 ft in thickness, which restricts ground-water movement into the lower Patapsco aquifer. The slope of the land surface and direction of surface water flow can be generally used to approximate the ground-water flow direction in the water-table aquifer. Generally, the slope of the water table



is a subdued replica of the land surface. This means that the water table will be highest below ridgetops and lowest in the valleys. The flow pattern in the deeper, confined aquifer (lower Patapsco) is not affected by local topography.

Water-level elevations obtained on a monthly basis between 30 October 1989 and 27 July 1991 for all onsite monitoring wells are listed in Table 2.2-1. Ground-water contour maps were constructed for the shallow and deep aquifers and are shown in Figures 2.2-3 and 2.2-4. The water-level elevation in the water-table aquifer is, on average, 145 ft above MSL, compared to 95 ft above MSL, on average, for the deep aquifer. The surrounding site topography and the presence of two 10-ft lifts of waste above the original topographic grade in Cells 1 and 2 have an influence on the ground-water flow direction in the water-table aquifer.

Figure 2.2-3 shows that the water table under the majority of the site slopes to the west following the surface water flow in this area. This figure also shows that the water table slopes to the southwest-south along the southern landfill boundary and to the east-southeast along the east and southeast landfill boundaries. The slope of the water table in this area is influenced primarily by the buildup of Cells 1 and 2, which results in a mounding of the water-table surface under these cells, thus creating a localized radial ground-water flow pattern.

The potentiometric surface for the confined aquifer (Figure 2.2-4) was developed using water-level measurements recorded during this study. It indicates that this surface slopes to the southeast consistent with the dip of the formation. The water-level elevation in MW-2D is consistent with the potentiometric surface of the lower Patapsco aquifer. However, the water level is below the elevation of the clay unit penetrated by this well (Figure 2.2-4). It may be that silty, fine sand deposits beneath the clay at this location are in effect part of the effective confining unit.

Slug tests were performed in selected monitoring wells in order to estimate hydraulic properties of the upper and lower Patapsco aquifers (Appendix F). Hydraulic conductivity values calculated from slug test data range from  $2.51 \times 10^{-5}$  to  $6.14 \times 10^{-3}$  cm/sec for the upper Patapsco aquifer (Table 2.2-2). The hydraulic conductivity values for MW-2S, MW-7S, MW-11, and MW-12S are representative of aquifers composed of fine sand and silty fine sand. The values for MW-5 and MW-9 are representative of mixtures of sand, silt, and clay material. These wells were partially screened in the underlying clay unit, and hydraulic conductivity estimates for the upper Patapsco aquifer may be somewhat low for these wells. Estimates of hydraulic conductivity for the lower Patapsco aquifer range from  $4.21 \times 10^{-4}$  to  $1.97 \times 10^{-3}$  cm/sec



(Table 2.2-2). These values are typical for aquifers composed of fine sand. Slug test data and graphs are presented in Appendix F.

Five soil samples, one from each deep test boring, were collected from the middle confining layer, which separates the upper and lower Patapsco aquifers, and submitted for falling head permeability analysis (see Appendix B for test procedure). Estimated permeabilities ranged from  $1.2 \times 10^{-8}$  to  $1.9 \times 10^{-7}$  cm/sec (Table 2.2-3). These permeability values are indicative of confining beds, i.e., beds which restrict vertical ground-water flow.

In order to further evaluate the effectiveness of this stratigraphic unit as a confining bed, a short-term pump test was performed on the MW-7S/7D well cluster. Monitoring well MW-7D (screened in the lower Patapsco) was pumped continuously for 4 hours while the water level in MW-7S (screened in the upper Patapsco) was monitored. Water level during pumping in MW-7D averaged about 73 ft below grade, providing a drawdown of approximately 32 ft. Water level in the observation well (MW-7S) was not affected by pumping. Therefore, the middle confining layer, which separates these two wells, effectively blocked hydraulic communication between the upper and lower Patapsco aquifers.

#### Ground-Water Use

Table 2.2-4 is a partial record of water supply wells within a 1-mi radius of the ASL and CFD. Figure 2.2-5 shows the approximate locations of the wells listed in Table 2.2-4. This information was compiled from a computer search conducted by the Maryland Department of the Environment (MDE) of well permit applications that have been filed since 1969, and does not include wells that were installed prior to 1969. The majority of the domestic wells are located to the east and north of the ASL and are screened in the lower Patapsco aquifer. This information does not identify any domestic use of the upper Patapsco aquifer in the vicinity of the ASL. However, this does not rule out the possibility that pre-1969 wells are in use in this area. Small residential communities and single family residences account for the majority of domestic wells in the vicinity of the study area. Public water is available along Patuxent Road east of the ASL.

Based on information from the Anne Arundel County Health Department there are two residences located along Waugh Chapel Road (628 and 654 Waugh Chapel Road) using private well water exclusively. The approximate locations of these two residences are shown in Figure 2.2-5. The Anne Arundel County Health Department also stated that there is no public water supply servicing Galloway Road east and southeast of the landfill. A survey conducted in September 1992 revealed a total of six residences along Galloway Road.

Several homes were noted on the east side of Patuxent Road, south of the intersection with Waugh Chapel Road. Only one visible well was observed within this area. Industry occupies the west side of Patuxent Road in this area, and no wells were observed at these facilities. Two fire hydrants are present in the industrial area, indicating the presence of public water.

The closest FGGM potable wells and their associated observation wells are located approximately 0.2 to 0.6 mi west, south, and southwest of the ASL. All of these wells are completed at depths in excess of 640 ft in the Patuxent Formation. The closest well to the southeast of the ASL is a domestic well (Permit No. 74-3512) located along Patuxent Road. Records for this well indicate that it is screened from 58 to 63 ft below grade and is completed in the lower Patapsco. The location of this well is somewhat approximate due to the lack of specific coordinates available from the well inventory search.

A new development, Piney Orchard, is currently being constructed east of Patuxent Road and south of Waugh Chapel Road. The developer of this property stated that Piney Orchard will utilize a public water supply. The Anne Arundel County utility department stated that the source of water for this community will be primarily derived from production wells at Maryland City, located west of FGGM, and Glen Burnie, located northeast of FGGM.

An additional community of six houses was observed on Fifth Avenue, which is located approximately 0.7 mi southeast of the CFD. Individual domestic water supply wells were observed at each of these residences. As shown in Table 2.2-4, the available records indicate that at least two of these wells are screened in the Lower Patapsco Formation. These residences are separated from the CFD and ASL by the Patuxent River.

#### 2.2.4 Terrestrial Resources

Terrestrial resources of the ASL site were characterized and evaluated by a variety of methods. Land use and land cover were evaluated by a combination of aerial photograph interpretation and field verification. Wetland-upland boundaries were determined by the approach described in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (1989). Wildlife information was compiled from field observations, from interaction with the Fort Meade Natural Resource Management Office, and from consultation with state and federal resource agencies, particularly concerning rare, threatened, and endangered species. Additional detailed descriptions of the methods and procedures are provided in Appendix A.9.



### Land Cover/Use Characterization

Land cover and land use are defined below as they apply to this report. Land cover is represented by the physical properties of the landscape, such as forest, field, impervious surface, or barren ground. These various components can be most easily mapped from aerial photographs. The land use and cover types were derived from interpretation of existing aerial photos (e.g., 1986 infrared photo) and were further refined by field investigations with detailed notes recorded on their composition and extent. The land cover types and acreages of the permitted ASL area include open grass/scrub fields (approximately 29 acres), unvegetated earth (approximately 25 acres), and forested areas (46 acres), along with relatively small areas of developed impervious surfaces (less than 1 acre).

Land use refers to how land is utilized and typically applies to man's management of the natural landscape. The land uses and the breakdown of acreages for this site are (1) waste disposal areas (approximately 70 acres), (2) undeveloped woodlands (approximately 30 acres), and (3) small areas of support/storage facilities (less than 1 acre).

### Upland Community Characterization

The majority of vegetative cover at the ASL that is not active landfill is a managed open grassy field (Figure 2.2-6). Vegetation identified in the field communities of the ASL is listed in Table 2.2-5. The landfill cap is inhabited predominantly by upland vegetation, including bushclovers, meadow fescue, broom sedge, pokeweed, goldenrod, field garlic, and crown vetch. However, the perimeter of the ASL cap contains many seep areas, particularly along the southern and eastern sides of the ASL.

The bunker area within the study area of the ASL was dominated by upland grasses with scattered trees. The trees in the bunker area were predominantly Virginia pine and also included Spanish red oak, white oak, sweet gum, red maple, and pin oak. Grasses included broom sedge, purple top, orchard grass, tall fescue, crab grass, timothy, bentgrass, and yellow bristle grass. Typical old field forbs were dominated by bushclover and included clovers, plantains, ragweed, asters, chickory, Queen Anne's lace, dandelion, mullein, yarrow, evening primrose, dock, and goldenrod.

Three stands of upland pine plantation were identified at the ASL (Figure 2.2-7). Vegetation identified in the upland woods is listed in Table 2.2-6. A small stand of Virginia pine is located on the northernmost "finger" of woods west of the active access road to the ASL. These woods are dense and include few other species. Cottonwood and cherry saplings



occur in the shrub layer, with scattered patches of broom sedge and poverty grass. The northern edge of the landfill has been planted in a mix of white, loblolly, and scrub pines, and the northeast corner of the landfill has been planted in loblolly pine.

Upland hardwood forest occurs along most of the western side of the ASL and bunker areas. These woods are codominated by white oak and beech. Other canopy species include red oak, southern red oak, chestnut oak, black cherry, red maple, hickory, and loblolly pine. Understory, shrub, and ground cover are relatively limited and are dominated by high bush blueberry. Other species include dogwood, holly, poison ivy, low bush blueberry, greenbrier, partridge berry, and saplings of the canopy species. Herbaceous ground cover was very limited and included spangle grass and ground cedar.

#### Wetland Community Characterization

The ASL and adjacent areas contain several wetland communities (Figure 2.2-8). The wetland identification method is described in Appendix A.9. As previously discussed, ground-water seeps occur along the base of the fill at the perimeter, especially along the eastern and southern sides. Two branches of a stream flow into the ASL and form a single channel in the bunker area. Wetlands also occur along the outside of the ASL perimeter road on the east side where the streams cross into the study area. The northernmost wetland is ponded and contains a number of dead pines. Dead and dying trees were also noted along the southern-facing slope of the landfill in the northwest corner of the site. This would indicate a recent change in hydrology, i.e., increased duration or extent of ponding. The landfill elevation is approximately 30 ft above the floor of the wet woods in this area, and the cap contains several 2- to 3-ft-deep erosion gullies. The tributary branches flow through the fill and emerge into a wet wooded area between the landfill and bunker areas. This woods has three projections or "fingers" (Figure 2.2-8). The northern and southern fingers contain portions of upland woods toward their outer edges. The remaining wooded area is wetland. The stream is ponded in two places in the bunker area and flows through a narrow strip of wet woods to join another stream at the northwestern corner of the study area. A large pond is formed at this confluence. Total wetland acreage within the permitted ASL area is approximately 28 acres.

Seeps along the landfill perimeter were generally codominated by soft rush and wool grass. Low-cut bushes of birch, elderberry, sycamore, maple, Russian olive, sweet gum, willow, and multiflora rose occurred sporadically in these areas. Other species identified in the seeps included common reed, cattails, smartweed, bentgrasses, asters, goldenrods, Asian tear-thumb, and



barnyard grass. The water discharged from these seeps was discolored with orange floc and had an organic slick (sheen) on the surface.

Vegetation identified in the wet woods associated with the ASL is listed in Table 2.2-7. Wetland woods associated with the ASL were generally dominated by red maple and also included pin oak, black gum, sweet gum, black birch, sycamore, white oak, beech, boxelder, willow oak, southern red oak, tulip poplar, cottonwood, Virginia pine, and loblolly pine. The understory is dominated by sweet bay and includes holly and immature individuals of the canopy species. Shrub and vine cover is dense and is dominated by pepperbush. Other shrubs and vines include greenbrier, poison ivy, Japanese honeysuckle, grape, alder, fetterbush, high bush blueberry, privet, arrow-woods, elderberry, and blackberry. Ground cover was dominated by cinnamon fern and also included skunk cabbage, soft rush, false nettle, Japanese honeysuckle, fowl manna-grass, agrimony, field garlic, touch-me-not, seed box, Virginia chain fern, rough avens, buttercup, ground cedar, dyers bedstraw, and unidentified sedges. Open edges of the wet woods also included willow, common reed, thistle, goldenrod, purple love grass, Indian hemp, coltsfoot, and cattails.

The quality of the wetlands associated with the ASL varies by the type and location of the wetlands relative to the landfill. The wet woods in the central portion and along the west side are of relatively high quality. These mature stands are diverse and provide wildlife habitat, flood and sediment retention, and possibly removal/transformation of substances coming from the landfill seeps. The several ponds along the stream in the bunker area, and where the stream joins the larger tributary at the northwest corner of the study area, function as sediment traps. The wetland seeps along the open field perimeter of the landfill are of lower quality. These wetlands have limited diversity and size and are not optimally located for flood or sediment retention. The water discharge from these wetlands is discolored and has a strong odor.

#### Wildlife Resource Characterization

Wildlife habitat is limited in the vicinity of the active landfill cells due to the nature of the operation, but is more developed around the revegetated older cells and on the perimeter of the operation. Habitat components in the vicinity of the landfill include deciduous wet woods, deciduous uplands, managed pine stands, and mixed pine and deciduous woods. Some areas (particularly north of the main access road) contained several dead cavity trees, which are important to cavity-dwelling species (e.g., woodpeckers, owls, and flying squirrels). The herbaceous vegetation of the covered landfill cells includes foxtail, meadow fescue, goldenrod,



brome grass, and others. This area provides some nesting opportunities for upland birds, such as bobwhite quail, especially near the woodland and shrub edges. These areas also provide brood cover and areas to feed on insects, an important early development protein source for many birds. The habitat potential of the area has been enhanced by wildlife food and cover plantings such as crabapple trees, crown vetch, and Korean lespedeza.

Wildlife presence observed by EA field personnel included white-tailed deer, raccoon, groundhogs, frogs, hawks (including red-tailed), seagulls, crows, and kestrels. In the bunker area, eastern kingbirds, common flicker, robin, bluebird, and other songbirds were observed. A more comprehensive list of fauna identified at the ASL is presented in Table 2.2-8.

#### 2.2.5 Aquatic Resources

Aquatic resources in the vicinity of the ASL consist of three small streams which join together and flow into a series of two ponds. Two of the streams originate west of the ASL and flow into the bunker area. These two streams are narrow (2-4 ft wide) and shallow (2-4 in. deep). Their substrate was discolored by orange colored floc, and an iridescent sheen was present on the surface of the water. The third stream appears to originate in a seep area of wetland woods just south of the bunker area. This stream is smaller, about 1-2 ft wide and 1-2 in. deep, and it joins one of the other two streams just before entering the bunker area. Figure 2.2-8 shows the aquatic resource sampling locations.

The ponds are located inside the bunker area and are about 1 to 2 acres in area and of unknown depths. The water of both ponds appeared to have a suspended sediment with an orange-brown color.

ELEVATION  
IN FEET  
ABOVE MSL

SOUTH  
A'

200

160

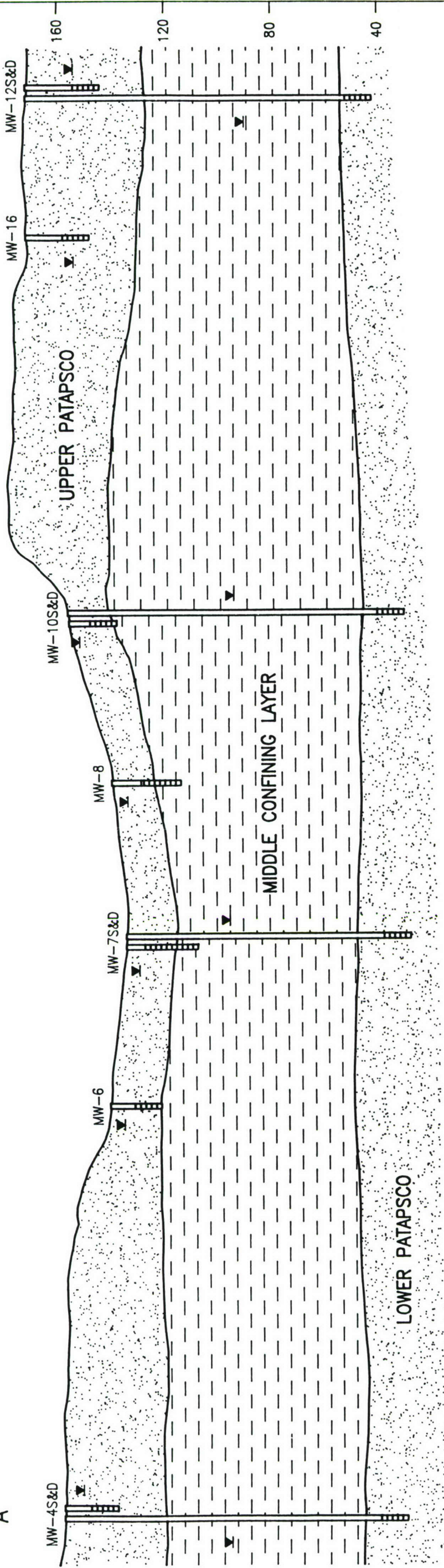
120

80

40

0

NORTH  
A



**LEGEND**



CLAY



SAND



WATER LEVEL (21 MAY 91)



WELL SCREEN INTERVAL


**NOTES**

1. THE SUBSURFACE SECTIONS SHOWN REPRESENT OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.

2. SEE PLATE 1 FOR CROSS-SECTION LOCATION.

HORIZONTAL SCALE (FT)  
0 300 600

VERTICAL SCALE (FT)  
0 40 80

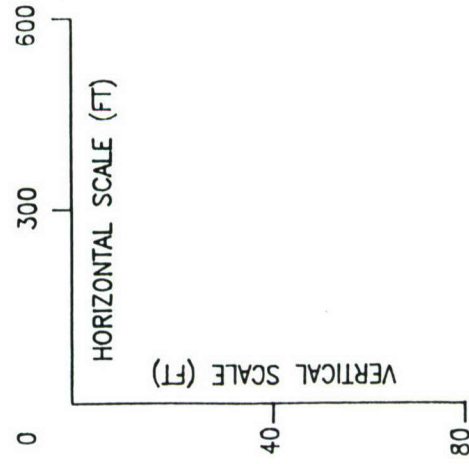
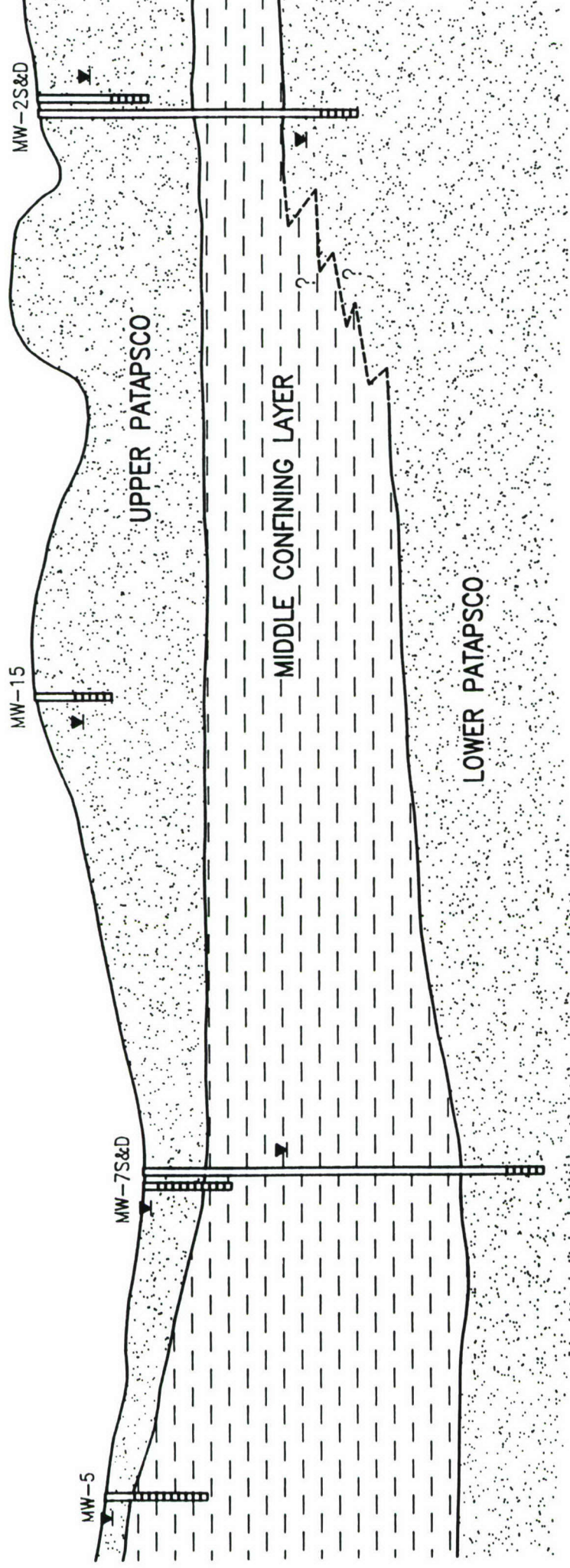
	EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	FORT MEADE REMEDIAL INVESTIGATION FORT MEADE, MARYLAND	ACTIVE SANITARY LANDFILL A-A' GEOLOGIC CROSS-SECTION	DESIGNED BY SAB	DRAWN BY MSM	DATE 9-30-91	PROJECT NO. 10559.05	FILE NAME XSASLNS
				CHECKED BY KWK	PROJECT MGR. SAB	SCALE AS SHOWN	DRAWING NO. -	FIGURE 2.2-1



WEST  
B

EAST  
B'

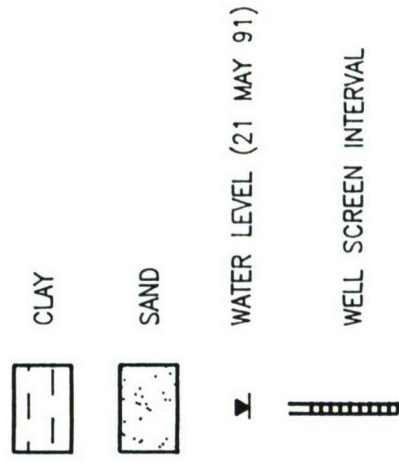
ELEVATION  
IN FEET  
ABOVE MSL



**NOTES**

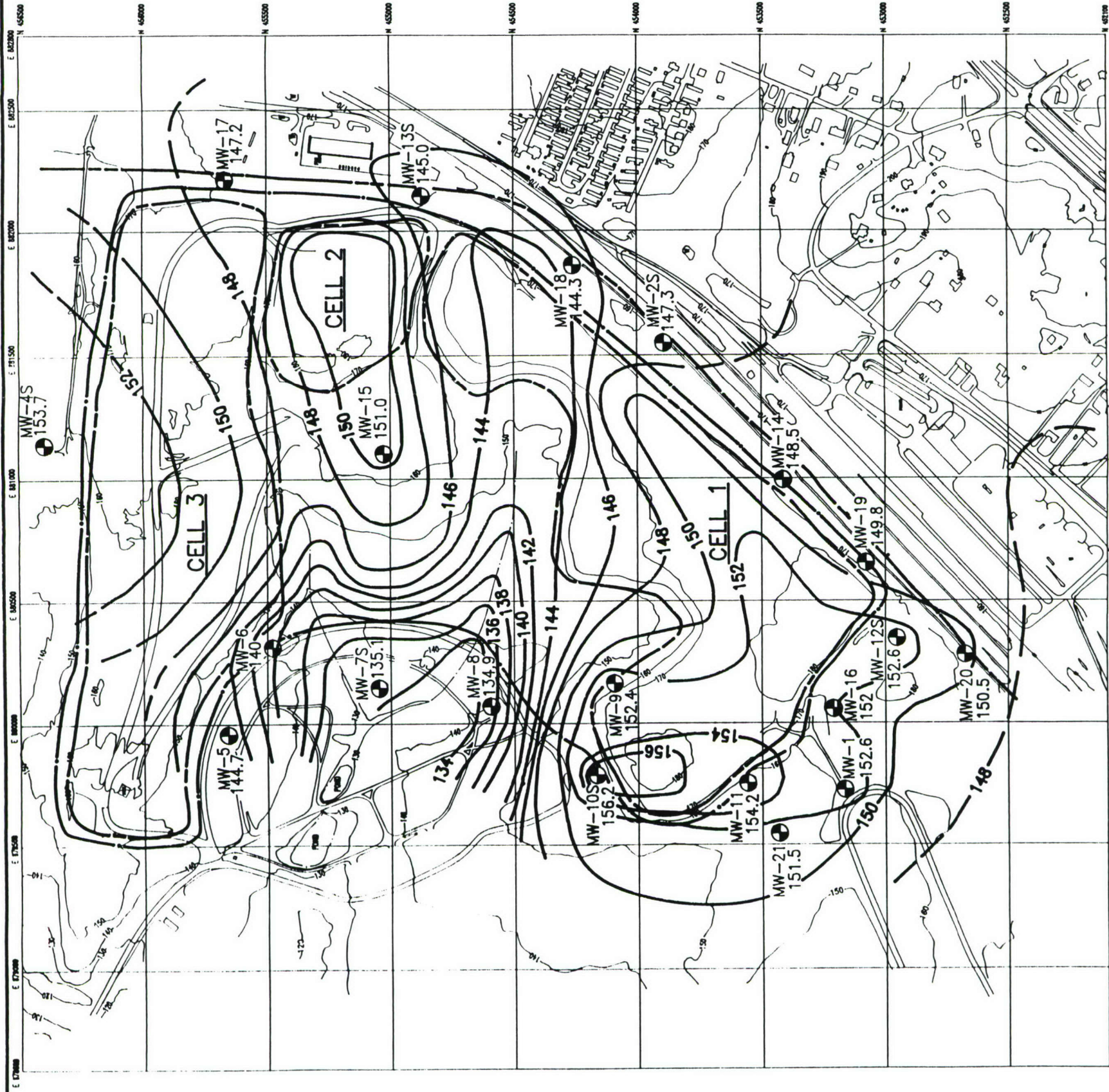
1. THE SUBSURFACE SECTIONS SHOWN REPRESENT OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.
2. SEE PLATE 1 FOR CROSS-SECTION LOCATION.

**LEGEND**



	FORT MEADE REMEDIAL INVESTIGATION FORT MEADE, MARYLAND	ACTIVE SANITARY LANDFILL B-B' GEOLOGIC CROSS-SECTION	DESIGNED BY SAB	DRAWN BY MSM	DATE 9-30-91	PROJECT NO. 10559.05	FILE NAME XSASLWE
			CHECKED BY KWK	PROJECT MGR. SAB	SCALE AS SHOWN	DRAWING NO. -	FIGURE 2.2-2



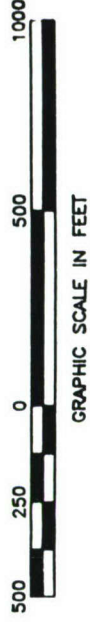


## LEGEND

- MW-16  
152  
●
- APPROXIMATE LIMIT OF PERMITTED LANDFILL AREA
- FORT MEADE RESERVATION BOUNDARY
- APPROXIMATE LANDFILL CELL BOUNDARY
- TOPOGRAPHIC CONTOUR IN FEET ABOVE MSL
- 148— GROUND-WATER CONTOUR IN FEET ABOVE MSL

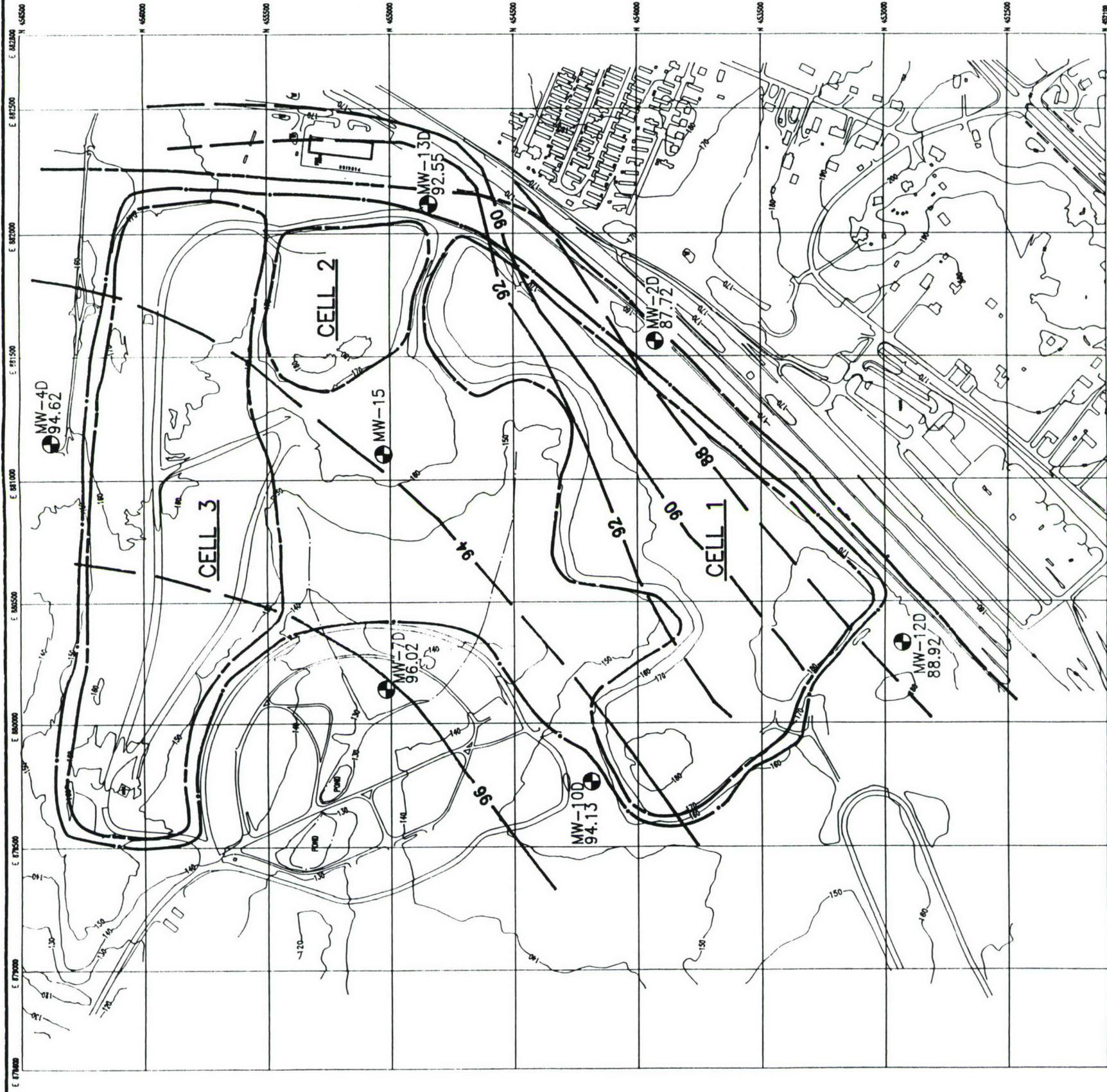
## NOTES

- CELL 1 AND 2 BOUNDARY OUTLINES AREA WHERE 2-10 FT. LIFTS HAVE BEEN PLACED OVER TRENCH FILL AREA.
- CELL 3 BOUNDARY DEPICTS APPROXIMATE EXTENT OF TRENCH FILL AREA.
- DASHED GROUND-WATER CONTOUR LINES INFERRED FROM SURFACE TOPOGRAPHY.
- WATER LEVEL ELEVATIONS DERIVED BY CALCULATING AN AVERAGE ELEVATION USING MEASUREMENTS COLLECTED FROM OCTOBER 1989 - JULY 1991.



 EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	FORT MEADE REMEDIAL INVESTIGATION FORT MEADE, MARYLAND	ACTIVE SANITARY LANDFILL UPPER PATAPSCO AQUIFER GROUND WATER CONTOUR MAP	DESIGNED BY	DRAWN BY	DATE	PROJECT NO.	FILE NAME
			SAB	MSM	9-30-91	10559.05	ASL-UGCM
			CHECKED BY	PROJECT MGR.	SCALE	DRAWING NO.	FIGURE
			KWK	SAB	1"=500'	-	2.2-3





## LEGEND

MW-12D  
88.92

MONITORING WELL LOCATION WITH GROUND-WATER  
ELEVATION IN FEET ABOVE MSL

—

APPROXIMATE LIMIT OF PERMITTED LANDFILL AREA

---

FORT MEADE RESERVATION BOUNDARY

---

APPROXIMATE LANDFILL CELL BOUNDARY

—100—

TOPOGRAPHIC CONTOUR IN FEET ABOVE MSL

—148—

GROUND-WATER CONTOUR IN FEET ABOVE MSL

## NOTES

1. CELL 1 AND 2 BOUNDARY OUTLINES AREA WHERE 2-10 FT. LIFTS HAVE BEEN PLACED OVER TRENCH FILL AREA.
2. CELL 3 BOUNDARY DEPICTS APPROXIMATE EXTENT OF TRENCH FILL AREA.
3. DASHED GROUND-WATER CONTOUR LINES INFERRED FROM SURFACE TOPOGRAPHY.
4. WATER LEVEL MEASUREMENTS COLLECTED 10 JANUARY 1991



GRAPHIC SCALE IN FEET

ACTIVE SANITARY LANDFILL  
LOWER PATAPSCO AQUIFER  
GROUND-WATER CONTOUR MAP

FORT MEADE  
REMEDIAL INVESTIGATION  
FORT MEADE, MARYLAND

EA ENGINEERING,  
SCIENCE, AND  
TECHNOLOGY, INC.



DESIGNED BY SAB	DRAWN BY PMS	DATE 10-9-91	PROJECT NO. 10559.05	FILE NAME ASL-LGCM
CHECKED BY KWK	PROJECT MGR. SAB	SCALE 1"=500'	DRAWING NO. —	FIGURE 2.2-4



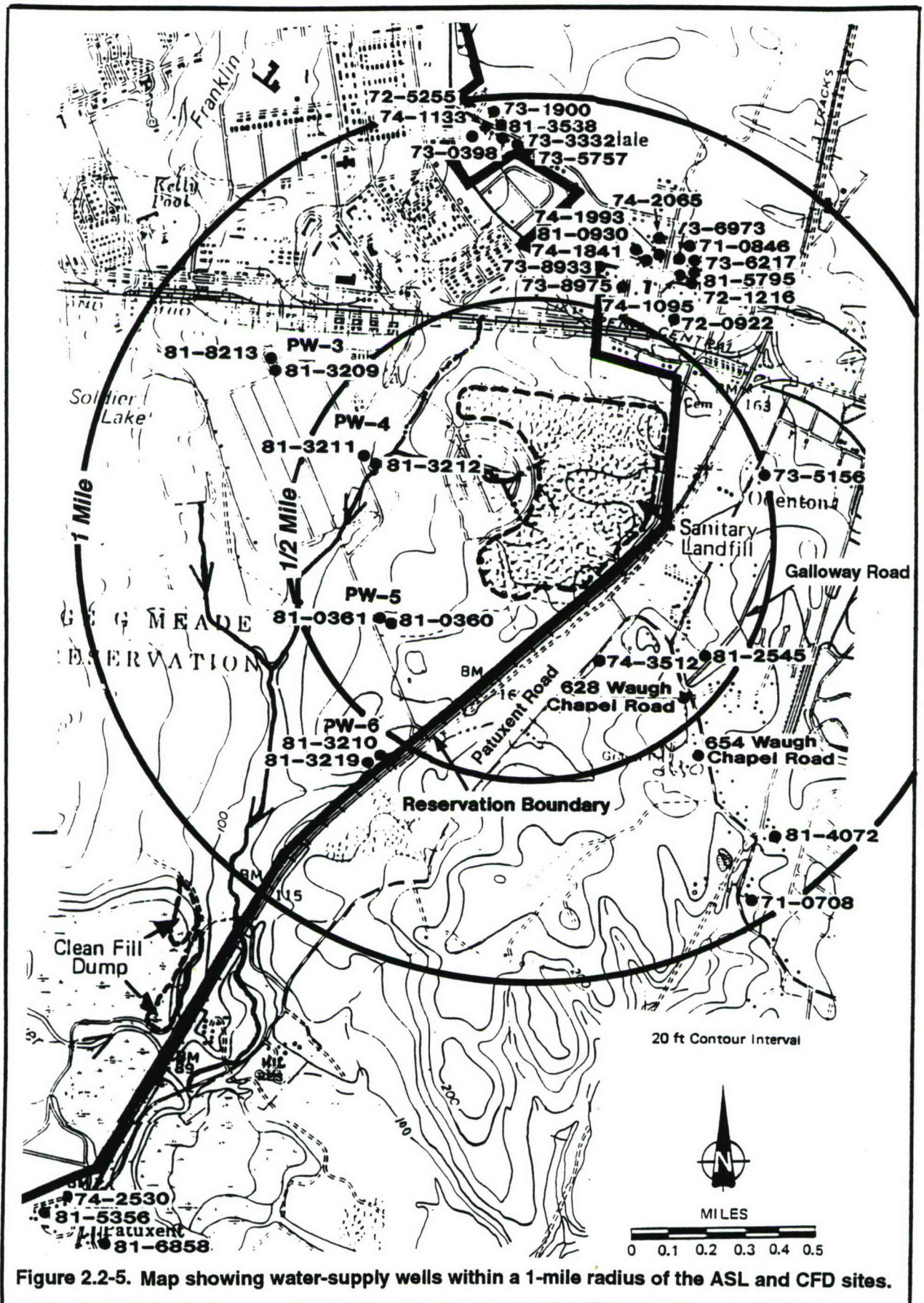
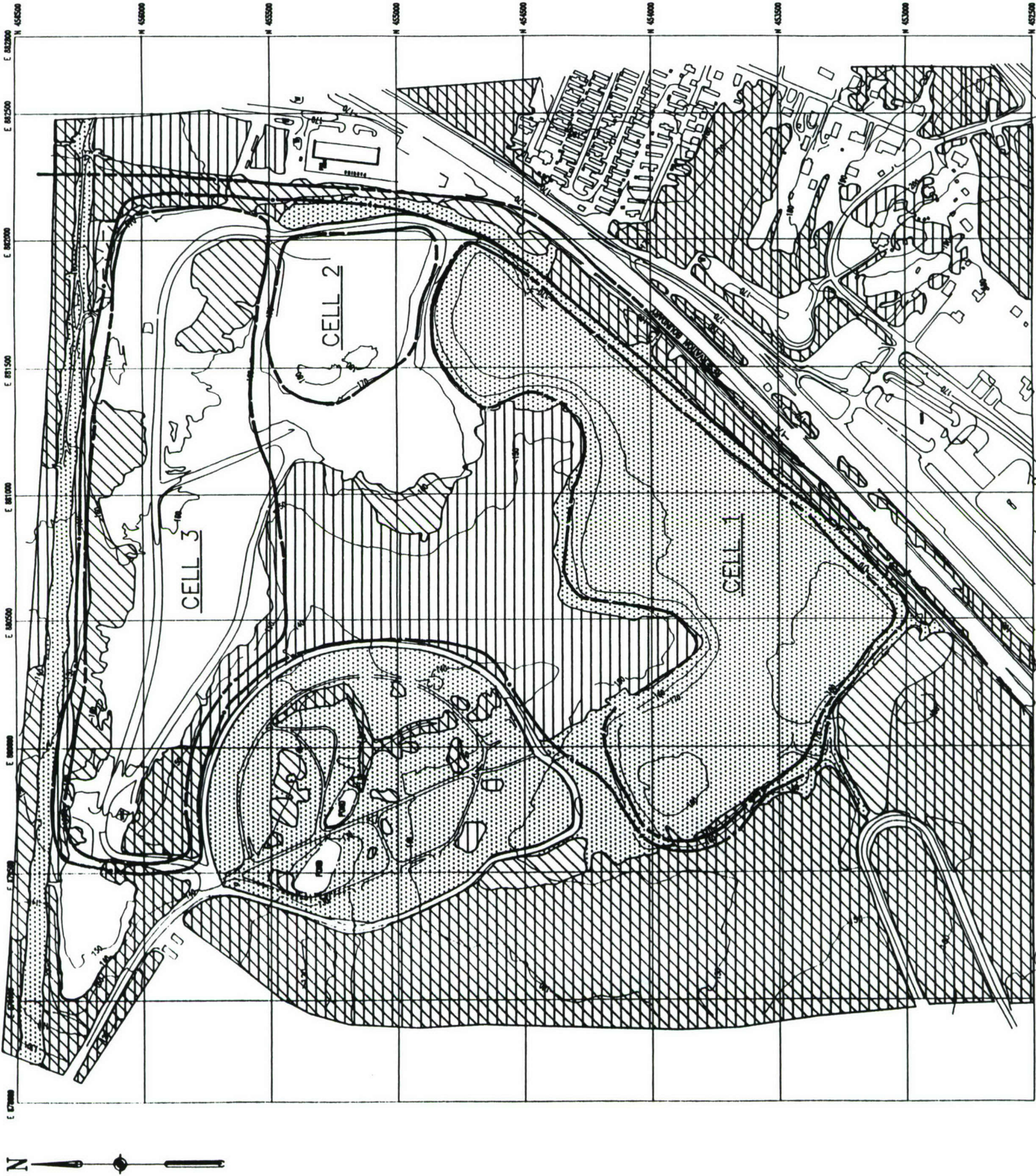


Figure 2.2-5. Map showing water-supply wells within a 1-mile radius of the ASL and CFD sites.





**LEGEND**

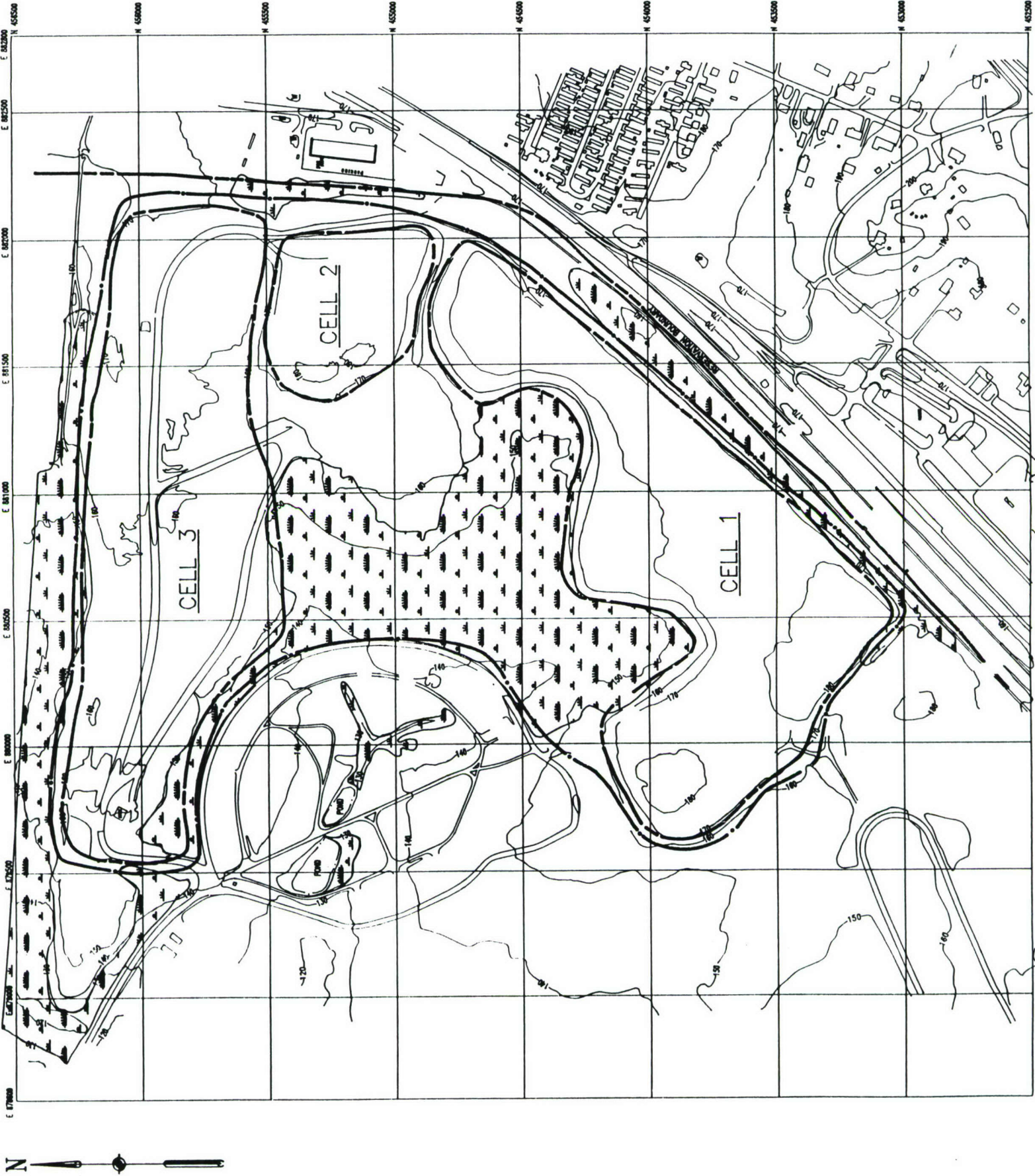
- IMPERVIOUS SURFACE/BARE SOIL
- PINETREES
- SCRUB/SHRUB
- DECIDUOUS WOODS
- HERBACEOUS/GRASSED
- MIXED PINE/DECIDUOUS WOODS

TOPOGRAPHIC CONTOUR IN FEET ABOVE MSL




 EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	FORT MEADE REMEDIAL INVESTIGATION FORT MEADE, MARYLAND	ACTIVE SANITARY LANDFILL VEGETATIVE COMMUNITIES	DESIGNED BY EWM	DRAWN BY MSM	DATE 9-30-91	PROJECT NO. 10559.05	FILE NAME ASL-BVW2
			CHECKED BY KWK	PROJECT MGR. SAB	SCALE 1"=500'	DRAWING NO. —	FIGURE 2.2-6



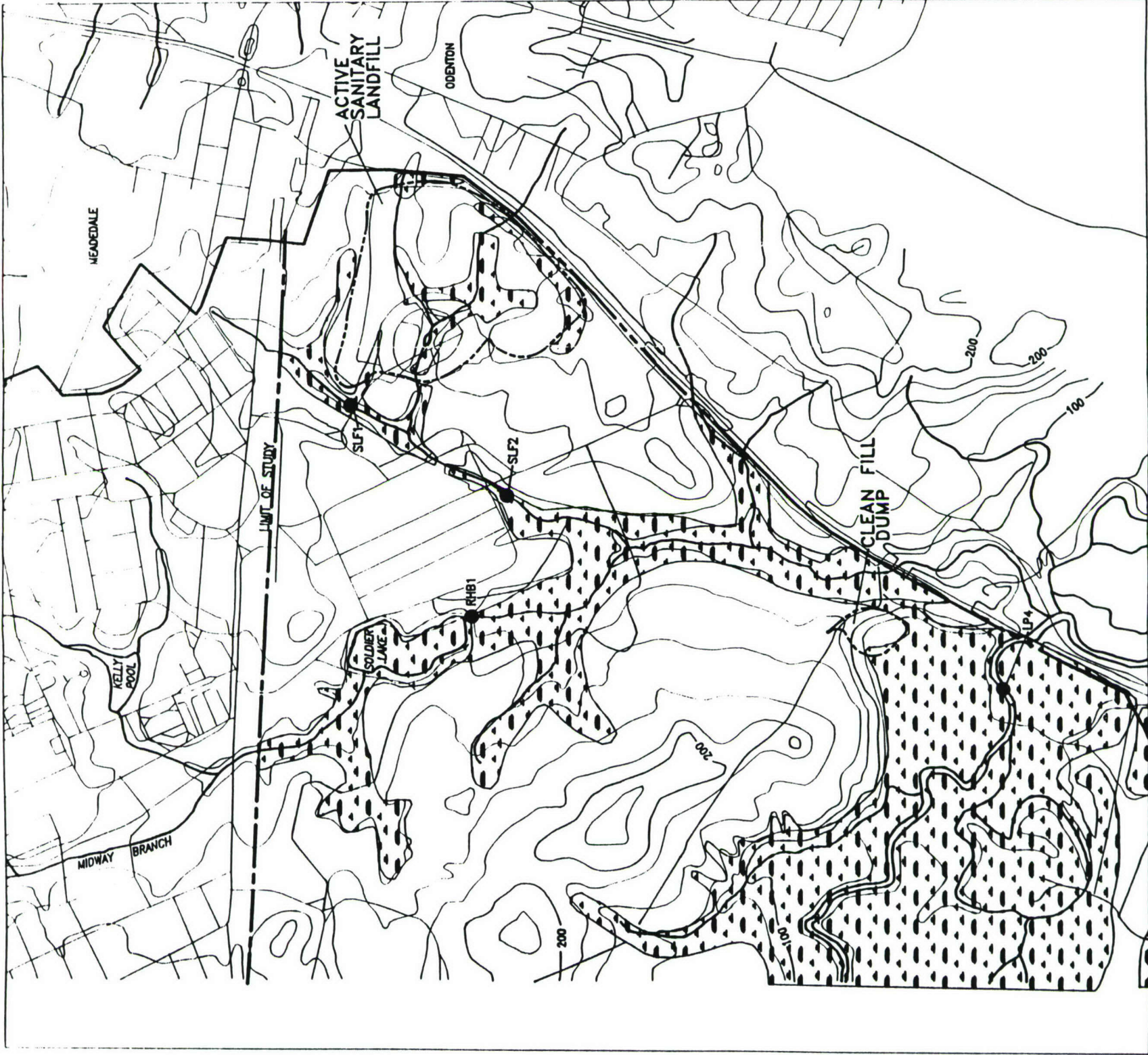


**LEGEND**



 <b>EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.</b>	FORT MEADE REMEDIAL INVESTIGATION FORT MEADE, MARYLAND	ACTIVE SANITARY LANDFILL NON-TIDAL WETLANDS MAP				DESIGNED BY EWM	DRAWN BY MSM	DATE 9-30-91	PROJECT NO. 10559.05	FILE NAME ASL-BW2
						CHECKED BY KWK	PROJECT MGR. SAB	SCALE 1"=500'	DRAWING NO. -	FIGURE 2.2-7





LEGEND

- FISH AND BENTHIC INVERTEBRATE SAMPLING STATIONS
- WETLAND



 <b>EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.</b>	<b>FORT MEADE REMEDIAL INVESTIGATION</b> FORT MEADE, MARYLAND	<b>ESTIMATED WETLAND DISTRIBUTION AND AQUATIC RESOURCE SAMPLING LOCATIONS IN THE VICINITY OF THE FORT MEADE REMEDIAL INVESTIGATION SITES</b>				DESIGNED BY EWM	DRAWN BY PMS	DATE 9-24-91	PROJECT NO. 10559.05	FILE NAME ASL-CFDW
						CHECKED BY KWK	PROJECT MGR. SAB	SCALE 1"=1800'	DRAWING NO. —	FIGURE 2.2-8



TABLE 2.2-1 FORT MEADE SANITARY LANDFILL WATER-LEVEL DATA

Well No.	Reference <sup>(a)</sup> Elevation (ft)	Water-Level Elevation (ft)						
		30 OCT 89	29 NOV 89	27 DEC 89	22 JAN 90	8 FEB 90	1 MAR 90	JUL 90
MW-1	163.18	153.91	153.81	149.88	154.20	154.69	154.36	154.02
MW-2S	163.93	148.17	147.51	146.95	146.77	147.09	146.86	148.37
MW-2D	162.67	89.35	89.22	89.21	88.61	88.11	88.09	89.53
MW-3	--	--	--	--	--	--	--	--
MW-4S	161.88	154.11	154.11	153.90	154.33	154.90	154.70	154.28
MW-4D	161.71	97.19	97.93	99.33	--	95.86	96.95	100.56
MW-5	148.50	144.71	145.17	144.25	145.08	145.58	144.85	143.64
MW-6	143.77	139.35	139.26	139.03	139.27	139.57	139.27	138.69
MW-7S	137.99	135.48	135.48	135.13	135.42	135.60	135.29	134.82
MW-7D	137.37	97.00	96.97	97.09	96.73	96.35	96.31	97.59
MW-8	141.76	135.10	135.11	134.78	134.18	133.76	135.15	134.73
MW-9	157.78	152.50	152.43	152.17	152.11	151.98	152.41	152.47
MW-10S	159.39	156.34	155.95	155.74	155.75	155.57	156.41	156.47
MW-10D	159.62	95.12	95.08	95.17	94.13	93.86	94.46	95.65
MW-11	159.94	155.17	155.24	154.84	152.53	152.17	155.29	150.73
MW-12S	174.44	153.22	152.92	152.69	152.79	152.54	152.82	153.69
MW-12D	174.52	89.89	89.89	90.02	88.79	88.44	89.13	90.31
MW-13S	169.16	145.42	145.08	144.74	145.70	145.25	144.43	146.06
MW-13D	168.05	--	--	--	92.70	92.29	--	94.01
MW-14	165.68	149.07	148.80	148.38	148.76	148.49	148.27	148.76
MW-15	165.47	151.17	151.01	150.69	150.51	152.65	151.40	150.51
MW-16	174.96	143.81	153.51	153.26	153.01	146.36	153.83	153.01
MW-17	171.81	--	--	--	147.86	144.97	--	147.86
MW-18	167.84	--	--	--	--	--	--	146.32
MW-19	170.01	--	--	--	--	--	--	150.54
MW-20	171.70	--	--	--	--	--	--	152.07
MW-21	156.89	--	--	--	--	--	--	151.97

(a) Reference elevation is top of PVC referenced to mean sea level.



TABLE 2.2-1 (Extended)

Well No.	Reference <sup>(a)</sup> Elevation (ft)	Water-Level Elevation (ft)									
		AUG 90	SEP 90	OCT 90	1 NOV 90	26 NOV 90	10 JAN 91	12 FEB 91	27 JUL 91		
MW-1	163.18	151.97	151.10	150.12	150.36	150.33	153.50	154.26	149.38		
MW-2S	163.93	147.81	147.48	147.16	147.01	146.78	147.21	--	146.41		
MW-2D	162.67	87.61	74.02	87.17	87.47	88.03	87.72	88.57	88.45		
MW-3	--	--	--	--	--	--	--	--	--		
MW-4S	161.88	153.47	152.83	--	152.59	152.55	152.67	--	151.46		
MW-4D	161.71	96.16	94.40	--	94.44	94.75	94.62	--	93.34		
MW-5	148.50	144.37	143.78	143.32	144.68	144.47	146.40	144.80	142.85		
MW-6	143.77	138.82	138.67	138.45	139.03	139.06	139.75	139.32	138.45		
MW-7S	137.99	134.83	134.39	134.17	134.81	134.96	136.01	135.39	133.76		
MW-7D	137.37	96.29	96.19	96.23	95.96	96.23	96.02	96.61	95.17		
MW-8	141.76	134.65	134.18	133.76	134.68	134.65	135.79	135.16	133.17		
MW-9	157.78	152.76	152.11	151.98	152.09	151.94	152.14	152.68	151.90		
MW-10S	159.39	156.27	155.75	155.57	155.89	155.76	156.79	156.59	155.60		
MW-10D	159.62	94.28	94.13	93.86	93.99	94.24	94.13	109.82	93.20		
MW-11	159.94	153.24	152.53	152.17	153.36	154.11	156.02	155.19	151.91		
MW-12S	174.44	153.08	152.79	152.54	152.31	151.97	151.54	151.54	152.17		
MW-12D	174.52	88.96	88.79	88.44	88.73	89.02	88.92	89.57	87.73		
MW-13S	169.16	145.94	145.70	145.25	144.95	144.62	144.42	145.02	143.66		
MW-13D	168.05	92.91	92.70	92.29	92.31	92.80	92.55	93.15	91.65		
MW-14	165.68	149.18	148.76	148.49	148.31	148.04	148.23	148.84	147.36		
MW-15	165.47	151.72	150.51	152.65	150.61	149.87	150.03	151.25	149.53		
MW-16	174.96	154.48	153.01	146.36	152.36	151.94	152.07	153.18	152.28		
MW-17	171.81	148.81	147.86	144.97	147.02	146.61	146.46	147.36	146.37		
MW-18	167.84	145.86	145.59	144.92	144.89	144.69	144.58	137.88	144.29		
MW-19	170.01	150.50	149.91	149.48	149.53	149.04	149.63	149.98	148.32		
MW-20	171.70	151.03	150.35	149.84	149.46	149.58	150.27	151.18	149.08		
MW-21	156.89	150.92	149.87	149.29	150.74	151.44	154.21	153.64	148.62		

TABLE 2.2-2

HYDRAULIC CONDUCTIVITY VALUES DERIVED FROM SLUG TESTS  
CONDUCTED IN ASL MONITORING WELLS

<u>Well</u>	<u>Aquifer</u>	<u>cm/sec</u>
MW-2S	Upper Patapsco	$6.14 \times 10^{-3}$
MW-5 (Test 1)	Upper Patapsco	$2.51 \times 10^{-5}$
MW-5 (Test 2)	Upper Patapsco	$3.41 \times 10^{-5}$
MW-7S	Upper Patapsco	$1.70 \times 10^{-4}$
MW-9 (Test 1)	Upper Patapsco	$6.64 \times 10^{-5}$
MW-9 (Test 2)	Upper Patapsco	$1.29 \times 10^{-4}$
MW-11	Upper Patapsco	$9.09 \times 10^{-4}$
MW-12S	Upper Patapsco	$3.49 \times 10^{-4}$
MW-2D	Lower Patapsco	$6.20 \times 10^{-4}$
MW-7D	Lower Patapsco	$1.97 \times 10^{-3}$
MW-12D	Lower Patapsco	$4.21 \times 10^{-4}$



TABLE 2.2-3

ESTIMATED PERMEABILITIES OF FIVE SOIL SAMPLES COLLECTED WITH A SHELBY TUBE SAMPLER FROM THE MIDDLE CONFINING LAYER BETWEEN THE UPPER AND LOWER PATAPSCO AQUIFER AT THE ASL SITE

<u>Well</u>	<u>Sample Depth (ft)</u>	<u>Permeability (cm/sec)</u>
MW-2D	45.0-46.5	$1.2 \times 10^{-7}$
MW-4D	70.5-71.5	$4.6 \times 10^{-8}$
MW-7D	40.0-41.9	$5.3 \times 10^{-8}$
MW-10D	40.0-42.0	$1.2 \times 10^{-8}$
MW-12D	65.0-66.2	$1.9 \times 10^{-7}$

TABLE 2.2-4 PARTIAL RECORD OF WATER SUPPLY WELLS WITHIN A 1-MILE RADIUS OF THE ASL AND CFD SITES

State	Permit No.	Owner	Approximate Distance From Site (mi)	Date Completed	Depth of Well (ft)	Casing Depth (ft)	Casing Diameter (in.)	Screen Interval (ft)	Static Water Level Below Pumping face (ft)	Water Level When Pumping	Aquifer	Water Use* (gpm)	Pumping Rate (gpm)
AA-81-3214	U.S. Army	Range Rd, Fort Meade	0.6	10/84	740	640	2	640-740	94	98	Patuxent	T	10
AA-81-3209	U.S. Army	Range Rd, Fort Meade	0.5	8/84	647	479	2	479-647	95	105	Patuxent	T	5
AA-81-3213	U.S. Army	Range Rd, Fort Meade	0.5	10/84	647	476	2	476-647	91	103	Patuxent	T	5
AA-81-3211	U.S. Army	Range Rd, Fort Meade	0.2	10/84	683	583	2	583-683	86	98	Patuxent	T	5
AA-81-3212	U.S. Army	Range Rd, Fort Meade	0.2	9/84	677	575	2	575-677	88	103	Patuxent	T	5
AA-81-3210	U.S. Army	Range Rd, Fort Meade	0.6	10/84	749	611	2	611-749	94	101	Patuxent	T	20
AA-81-0360	U.S. Army	1 mi SW of Odenton	0.3	--	--	--	--	--	--	--	--	T	--
AA-81-0361	U.S. Army	1 mi SW of Odenton	0.3	--	--	--	--	--	--	--	--	T	--
AA-71-0708	John Crawford	Waugh Chapel Rd.	0.9	4/71	260	255	4	255-260	130	140	Lower Patapsco	D	25
AA-71-0846	James Thornton	Hale St, Odenton	0.4	6/71	138	133	4	133-138	70	75	Lower Patapsco	D	12
AA-72-0922	Harold A. Behringer	Duckens St, Odenton	0.2	3/72	193	188	4	188-193	85	90	Lower Patapsco	D	12
AA-72-1216	William McCreary	Annapolis Rd, Odenton	0.3	6/72	178	173	4	173-178	120	125	Lower Patapsco	D	12
AA-73-1521	Joseph C. Lyon	Berger St, Odenton	0.3	6/73	125	118	4	118-125	60	75	Lower Patapsco	D	20
AA-73-1656	Leroy Conway	Waugh Chapel Rd.	0.2	7/73	115	110	4	110-115	87	92	Lower Patapsco	D	12
AA-73-1900	Shirley Halsey	Berger St, Odenton	0.6	8/73	115	108	4	108-115	52	65	Lower Patapsco	D	20
AA-73-5156	William Smallwood	Patuxent Rd, Odenton	0.3	10/75	83	78	4	78-83	50	55	Lower Patapsco	D	15
AA-73-5255	Goldie McCullough	Berger St, Odenton	0.6	11/75	109	104	4	104-109	65	70	Lower Patapsco	D	15
AA-73-5452	Leon Savoy	Waugh Chapel Rd.	0.4	11/76	135	130	4	130-135	--	--	Lower Patapsco	D	18
AA-73-6217	Pauline V. Kimmett	Hale St, Odenton	0.4	8/76	195	190	4	190-195	120	185	Lower Patapsco	D	7
AA-73-6973	Gordon Phelps	Hale St, Odenton	0.4	3/77	138	133	4	133-138	80	90	Lower Patapsco	D	15
AA-73-7270	Elwood Myers	Bucklina Ave, Odenton	1.0	5/77	130	125	4	125-130	45	50	Lower Patapsco	D	15
AA-73-8933	RVR Mobil Station	Rt 175 & Owen Rd, Odenton	0.4	4/78	150	145	4	145-150	80	90	Lower Patapsco	I	35
AA-73-8975	Nelson S. Phelps	Baldwin Rd, Odenton	0.3	4/78	167	162	4	162-167	80	85	Lower Patapsco	D	15
AA-74-1133	Ronald Spencer	Berger St, Odenton	0.6	8/79	120	?	11	--	70	80	Lower Patapsco	D	26
AA-74-1841	Grace H. Green	Annapolis Rd, Odenton	0.4	4/80	170	165	4	165-170	80	85	Lower Patapsco	D	15
AA-74-1993	John Campbell	Nevada Ave, Odenton	0.4	6/80	112	107	4	107-112	63	85	Lower Patapsco	D	30
AA-74-2065	Harvey Behringer	Nevada Ave, Odenton	0.5	6/80	110	103	4	103-110	65	80	Lower Patapsco	D	20
AA-74-2516	Kiewit & Sons Co.	Patuxent Rd, Odenton	0.3	11/80	127	122	4	122-127	90	95	Lower Patapsco	I	12
AA-74-0404	Chaney Inc.	Patuxent Rd, Odenton	0.7	3/79	74	69	4	69-74	40	45	Lower Patapsco	D	20
AA-74-1094	Chaney Inc.	Patuxent Rd, Odenton	0.8	9/79	64	59	4	59-64	30	35	Lower Patapsco	D	15
AA-74-1095	Chaney Inc.	Patuxent Rd, Odenton	0.3	9/79	80	75	4	75-80	35	40	Lower Patapsco	D	15
AA-81-5356	Pearl Botts	Fifth Ave, Odenton	0.7	--	55	50	--	50-55	13	20	Lower Patapsco	D	10
AA-74-3512	Lawrence Shinski	Patuxent Rd, Odenton	0.2	8/81	63	58	4	58-63	40	45	Lower Patapsco	D	20

\* T - Test Well

D - Domestic Well

I - Industrial Well



TABLE 2.2-4 (Cont.)

State Permit No.	Owner	Approximate Distance From Site (mi)	Date Com- pleted	Depth of Well (ft)	Cas- ing Depth (ft)	Cas- ing Diam. (in.)	Screen Interval (ft)	Static Water Level Below Sur- face (ft)	Water Level When Pump- ing (ft)	Aquifer	Water Use* (gpm)	Pump- ing Rate (gpm)
AA-81-3538	Fumiko Sommerhoff	0.6	8/84	127	122	4	122-127	70	80	Lower Patapsco	D	10
AA-81-0930	William Pumphrey	0.4	10/82	160	155	4	155-160	80	90	Lower Patapsco	D	25
AA-81-5795	C & J Affiliates	0.4	12/85	165	175	4	165-175	80	110	Lower Patapsco	D	40
AA-81-2545	William Dorsey	0.4	11/83	100	80	4	80-100	70	80	Lower Patapsco	D	15
AA-74-2530	Clarke Howard, Jr.	0.7	--	130	125	--	125-130	8	20	Lower Patapsco	D	30
AA-81-4072	Lee Robey	0.8	12/84	134	129	4	129-134	95	105	Lower Patapsco	D	7

TABLE 2.2-5 VEGETATION IDENTIFIED IN THE OPEN FIELDS AT THE ASL, FORT MEADE

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
TREES		
<u>Acer rubrum</u>	Red maple	FAC
<u>Liquidambar styraciflua</u>	Sweetgum	FAC
<u>Pinus virginiana</u>	Virginia pine	UP*
SHRUBS		
<u>Elaeagnus angustifolia</u>	Russian olive	FACU
<u>Lonicera tatarica</u>	Tartarian honeysuckle	FACU
<u>Rosa multiflora</u>	Multiflora rose	FACU
<u>Rubus flagellaris</u>	Dewberry	UP*
<u>Rubus occidentalis</u>	Black raspberry	UP*
VINES		
<u>Lonicera japonica</u>	Japanese honeysuckle	FAC
GRASSES, SEDGES, AND RUSHES		
<u>Agrostis hyemalis</u>	Winter bentgrass	FAC
<u>Agrostis perennans</u>	Bentgrass	FACU
<u>Andropogon virginicus</u>	Broomsedge	FACU
<u>Bromus japonicus</u>	Japanese chess	FACU
<u>Dactylis glomerata</u>	Orchard grass	FACU
<u>Danthonia spicata</u>	Poverty grass	UP*
<u>Dichanthelium clandestinum</u>	Deer tongue witchgrass	FAC
<u>Digitaria sanguinalis</u>	Hairy crabgrass	FACU
<u>Echinochloa crusgalli</u>	Barnyard grass	FACU
<u>Elymus virginicus</u>	Virginia wild-rye	FACW
<u>Eragrostis spectabilis</u>	Showy lovegrass	UP*
<u>Festuca pratensis</u>	Meadow fescue	FACU
<u>Juncus effusus</u>	Soft rush	FACW

(a) Hydrophytic status follows Reed, P.B. Jr. (1988) The U.S. Fish and Wildlife National List of Plant Species that Occur in Wetlands unless indicated otherwise. Abbreviations:

OBL = Obligate (found in wetlands in more than 99% of all findings)

FACW = Faculative wetland (66-99%)

FAC = Faculative (33-66%)

FACU = Faculative upland (1-33%)

UP = Upland (<1%)

\* Hydrophytic status not reported; status presented is based on professional judgment and is supported by appropriate literature.



TABLE 2.2-5 (Cont.)

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
GRASSES, SEDGES, AND RUSHES (Cont.)		
<u>Juncus tenuis</u>	Slender rush	FAC
<u>Phleum pratense</u>	Timothy	UP*
<u>Phragmites australis</u>	Reed	FACW
<u>Poa pratensis</u>	Kentucky bluegrass	FACU
<u>Rhynchospora capitellata</u>	Brownish beakrush	OBL
<u>Scirpus cyperinus</u>	Wool-grass	FACW
<u>Setaria glauca</u>	Yellow bristle grass	FAC
<u>Setaria italica</u>	Fox-tail bristlegrass	
<u>Tridens flavus</u>	Purple-top	FACU
HERBS		
<u>Achillia millefolium</u>	Yarrow	FACU
<u>Allium vineale</u>	Field garlic	FACU
<u>Ambrosia artemesifolia</u>	Common ragweed	FACU
<u>Apocynum cannabinum</u>	Indian hemp	FACU
<u>Asclepias syriaca</u>	Pink milkweed	UP*
<u>Aster spp.</u>	Asters	UNK
<u>Cardamine hirsuta</u>	Hairy bitter cress	FACU
<u>Centaurea maculata</u>	Batchelor's buttons	UP*
<u>Cerastium vulgatum</u>	Mouse-ear chicweed	FACU
<u>Cichorium intybus</u>	Chickory	UP*
<u>Coronaria varia</u>	Crown Vetch	UP*
<u>Datura stramonium</u>	Jimson weed	UP*
<u>Daucus carota</u>	Queen Anne's Lace	UP*
<u>Dianthus armeria</u>	Deptford pink	UP*
<u>Duchesnea indica</u>	Indian mock-strawberry	FACU
<u>Galium tinctorium</u>	Dye bedstraw	OBL
<u>Geranium carolinianum</u>	Cranesbill	UP*
<u>Krigia virginica</u>	False dandelion	UP*
<u>Lamium amplexicaule</u>	Henbit	UP*
<u>Lespedeza capitata</u>	Round-head bushclover	FACU
<u>Lespedeza stuevi</u>	Bush-clover	UP*
<u>Oenothera biennis</u>	Evening primrose	FACU
<u>Oxalis florida</u>	Wood sorrel	UP*
<u>Phytolacca americana</u>	Pokeweed	FACU
<u>Plantago lanceolata</u>	English plantain	UP*
<u>Plantago rugelii</u>	Black-seed plantain	FACU
<u>Polygonum</u>	Asian tearthumb	FAC
<u>Polygonum</u>	Smartweed	FACW
<u>Potentilla simplex</u>	Oldfield cinquefoil	FACU
<u>Prunella vulgaris</u>	Heal-all	FACU
<u>Pycnanthemum flexuosum</u>	Narrow-leaf mountain mint	FACW
<u>Rumex acetosella</u>	Sheep sorrel	FACU
<u>Rumex crispus</u>	Curly dock	FACU
<u>Solanum carolinense</u>	Horse nettle	UP*

TABLE 2.2-5 (Cont.)

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
HERBS (Cont.)		
<u>Solidago rugosa</u>	Wrinkled goldenrod	FAC
<u>Stellaria media</u>	Common starwort	UP*
<u>Taraxacum officinale</u>	Dandelion	FACU
<u>Tridanis perfoliatus</u>	Venus' looking-glass	UP*
<u>Trifolium repens</u>	White clover	FACU
<u>Verbascum thapsis</u>	Wooly mullein	UP*
<u>Veronica arvensis</u>	Corn speedwell	UP*
<u>Yucca filamentosa</u>	Yucca	UP*



TABLE 2.2-6 VEGETATION IDENTIFIED IN UPLAND WOODS NEAR THE ASL, FORT MEADE

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
TREES		
<u>Acer rubrum</u>	Red maple	FAC
<u>Cornus florida</u>	Dogwood	FACU
<u>Fagus grandifolia</u>	Beech	FACU
<u>Ilex opaca</u>	American holly	FACU
<u>Liquidambar styraciflua</u>	Sweetgum	FAC
<u>Liriodendron tulipifera</u>	Tulip tree	FACU
<u>Pinus strobus</u>	Eastern white pine	FACU
<u>Pinus taeda</u>	Loblolly pine	FAC
<u>Pinus virginiana</u>	Virginia pine	UP*
<u>Prunus serotina</u>	Black cherry	FACU
<u>Quercus alba</u>	White oak	FACU
<u>Quercus coccinea</u>	Scarlet oak	UP*
<u>Quercus falcata</u>	Southern red oak	FACU
<u>Quercus rubra</u>	Northern red oak	FACU
<u>Robinia pseudoacacia</u>	Black locust	FACU
SHRUBS		
<u>Castanea dentata</u>	American chestnut	UP*
<u>Clethra alnifolia</u>	Pepperbush	FAC
<u>Vaccinium corymbosum</u>	Highbush blueberry	FACW
<u>Vaccinium vacillans</u>	Lowbush blueberry	UP*
VINES		
<u>Lonicera japonica</u>	Japanese honeysuckle	FAC
<u>Mitchella repens</u>	Partridge-berry	FACU
<u>Rhus radicans</u>	Poison ivy	FAC
<u>Smilax rotundifolia</u>	Greenbrier	FAC

(a) Hydrophytic status follows Reed, P.B. Jr. (1988) The U.S. Fish and Wildlife National List of Plant Species that Occur in Wetlands unless indicated otherwise. Abbreviations:

OBL = Obligate (found in wetlands in more than 99% of all findings)

FACW = Faculative wetland (66-99%)

FAC = Faculative (33-66%)

FACU = Faculative upland (1-33%)

UP = Upland (<1%)

\* Hydrophytic status not reported; status presented is based on professional judgment and is supported by appropriate literature.

TABLE 2.2-6 (Cont.)

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
FERNS AND FERN ALLIES		
<u>Lycopodium</u> <u>fabelliforme</u>	Ground cedar	FACU
GRASSES, SEDGES, AND RUSHES		
<u>Chasmanthium</u> <u>laxum</u>	Spangle grass	FAC



TABLE 2.2-7 VEGETATION IDENTIFIED IN THE WETLANDS NEAR THE ASL, FORT MEADE

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
TREES		
<u>Acer negundo</u>	Box elder	FAC
<u>Acer rubrum</u>	Red maple	FAC
<u>Betula nigra</u>	River birch	FACW
<u>Caprinus caroliniana</u>	American hornbeam	FAC
<u>Fagus grandifolia</u>	Beech	FACU
<u>Ilex opaca</u>	American holly	FACU
<u>Juniperus virginiana</u>	Eastern red cedar	FACU
<u>Liquidambar styraciflua</u>	Sweetgum	FAC
<u>Liriodendron tulipifera</u>	Tulip tree	FACU
<u>Magnolia virginiana</u>	Sweetbay magnolia	FACW
<u>Nyssa sylvatica</u>	Black gum	FAC
<u>Pinus taeda</u>	Loblolly pine	FAC
<u>Pinus virginiana</u>	Virginia pine	UP*
<u>Platanus occidentalis</u>	American sycamore	FACW
<u>Populus deltoides</u>	Eastern cottonwood	FAC
<u>Prunus serotina</u>	Black cherry	FACU
<u>Pryus angustifolia</u>	Crabapple	UNK
<u>Quercus alba</u>	White oak	FACU
<u>Quercus bicolor</u>	Swamp white oak	FACW
<u>Quercus falcata</u>	Southern red oak	FACU
<u>Quercus palustris</u>	Pin oak	FACW
<u>Quercus phellos</u>	Willow oak	FAC
<u>Salix nigra</u>	Black willow	FACW
SHRUBS		
<u>Alnus serrulata</u>	Alder	OBL
<u>Clethra alnifolia</u>	Pepperbush	FAC
<u>Leucothoe racemosa</u>	Fetter-bush	FACW
<u>Ligustrum vulgare</u>	European privet	FACU
<u>Rhododendron canescens</u>	Hoary azalea	FACW
<u>Rosa palustris</u>	Swamp rose	OBL

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FAC = Faculative (33-66%)

FACU = Faculative upland (1-33%)

UP = Upland (<1%)

\*. Hydrophytic status not reported; status presented is based on professional judgment and is supported by appropriate literature.

TABLE 2.2-7 (Cont.)

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
SHRUBS (Cont.)		
<u>Rubus occidentalis</u>	Blackberry	UP*
<u>Sambucus canadensis</u>	American elder	FACW
<u>Vaccinium corymbosum</u>	Highbush blueberry	FACW
<u>Viburnum recognitum</u>	Northern arrow-wood	FACW
VINES		
<u>Lonicera japonica</u>	Japanese honeysuckle	FAC
<u>Rhus radicans</u>	Poison ivy	FAC
<u>Smilax glauca</u>	Cat greenbrier	FACU
<u>Smilax rotundifolia</u>	Greenbrier	FAC
<u>Vitis rotundifolia</u>	Muscadine grape	FAC
FERNS AND FERN ALLIES		
<u>Lycopodium fabelliiforme</u>	Ground cedar	FACU
<u>Lycododium inundatum</u>		
<u>Osmunda cinnamomea</u>	Cinnamon fern	FACW
<u>Sphagnum</u> spp.	Peat moss	OBL
<u>Thelypteris noveboracensis</u>	New York fern	FAC
<u>Thelypteris thelypteroides</u>	Marsh fern	FACW
<u>Woodwardia areolata</u>	Netted chain fern	FACW
<u>Woodwardia virginica</u>	Virginia chain fern	OBL
GRASSES, SEDGES, AND RUSHES		
<u>Carex</u> spp.	Sedges	UNK
<u>Chasmanthium laxum</u>	Spangle grass	FAC
<u>Glyceria striata</u>	Fowl mannagrass	OBL
<u>Juncus effusus</u>	Soft rush	FACW
<u>Phalaris arundinacea</u>	Reed canary grass	FACW
<u>Phragmites australis</u>	Common reed	FACW
<u>Scirpus cyperinus</u>	Wool-grass	FACW
HERBS		
<u>Acorus calamus</u>	Sweetflag	OBL
<u>Agrimonia parviflora</u>	Small-flowered agrimony	FAC
<u>Allium vineale</u>	Field garlic	FACU
<u>Boehmeria cylindrica</u>	False nettle	FACW
<u>Cirsium vulgare</u>	Thistle	FACU
<u>Galium tinctorium</u>	Dyers bedstraw	OBL
<u>Geum laciniatum</u>	Rough avens	FAC
<u>Impatiens capensis</u>	Spotted touch-me-not	FACW
<u>Ludwigia alternifolia</u>	Bushy seedbox	FACW
<u>Ranunculus septrionalis</u>	Swamp buttercup	OBL



TABLE 2.2-7 (Cont.)

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
HERBS (Cont.)		
<u>Solidago</u> spp.	Goldenrod	UNK
<u>Symplocarpus foetida</u>	Skunk cabbage	OBL
<u>Tussilago farfara</u>	Coltsfoot	FACU
<u>Typha latifolia</u>	Broad-leaf cattail	OBL

TABLE 2.2-8 WILDLIFE PRESENCE OBSERVED AT THE REMEDIAL INVESTIGATION SITES, FORT MEADE

<u>Scientific Name</u>	<u>Common Name</u>
BIRDS	
<u>Philohela minor</u>	American woodcock
<u>Aix sponsa</u>	Wood duck
<u>Ardea herodias</u>	Great-blue heron
<u>Anas platyrhynchos</u>	Mallard
<u>Branta canadensis</u>	Canada goose
<u>Larus argentatus</u>	Herring gull <sup>(a)</sup>
<u>Corvus brachyrhynchos</u>	Common crow <sup>(a)</sup>
<u>Cathartes aura</u>	Turkey vulture <sup>(a)</sup>
<u>Butea jamaicensis</u>	Red-tailed hawk <sup>(a)</sup>
<u>Falco sparverius</u>	American kestrel <sup>(a)</sup>
<u>Colaptes auratus</u>	Common flicker <sup>(a)</sup>
<u>Turdus migratorius</u>	American robin <sup>(a)</sup>
<u>Sialia sialis</u>	Eastern bluebird <sup>(a)</sup>
MAMMALS	
<u>Odocoileus virginianus</u>	White-tailed deer <sup>(a)</sup>
<u>Procyon lotor</u>	Raccoon <sup>(a)</sup>
<u>Marmota monax</u>	Ground hog <sup>(a)</sup>
<u>Vulpes vulpes</u>	Red fox
AMPHIBIANS	
<u>Pseudacris triseriata feriarum</u>	Upland chorus frog <sup>(a)</sup>
<u>Hyla crucifer crucifer</u>	Northern spring peeper <sup>(a)</sup>
REPTILES	
<u>Coluber constrictor constrictor</u>	Northern black racer <sup>(a)</sup>

(a) Species presence identified in the vicinity of the Active Sanitary Landfill.



## 2.3 NATURE AND EXTENT OF CONTAMINATION

### 2.3.1 General Analytical Program Information

All samples were analyzed in accordance with USATHAMA certified analytical methods. The analytical parameter list consisted of the Target Compound List (TCL) and the Target Analyte List (TAL). The TCL includes volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs). The TAL includes cyanide and total and dissolved metals for ground-water samples and total metals and cyanide for surface water, surficial soil, stream sediment, leachate, and field and rinsate blank samples. The data generated from the analysis of the field samples collected in March-April 1991 are organized by matrix group in Appendix H.1 through H.5. The quality assurance (QA) data are included in Appendix H.6. The trip blanks were analyzed for VOCs and the field blanks were analyzed for the full TCL and TAL (total metals) list of parameters. All of the trip blank results were nondetectable for VOCs. The positive field blank data are included in the summary tables and will be discussed with the associated field sample data. Appendix J provides the USATHAMA certified method number, certified reporting limit for certified compounds, and detection limits for noncertified compounds for the TCL/TAL parameters.

The number of field samples per matrix that were collected and analyzed and the corresponding report section in which the data are presented and discussed are as follows:

<u>Matrix</u>	<u>No. of Samples</u>	<u>Section</u>
Surficial soil	3	2.3.2
Surface water	6	2.3.3
Stream sediment	6	2.3.3
Ground water	28	2.3.4
Leachate	3	2.3.5

The analytical summary tables presented in this report list only the compounds and analytes that were detected in one or more samples for the respective matrix; i.e., compounds and analytes not listed in the summary tables were not detected in any sample. In addition, the summary analytical tables list the tentatively identified compounds (TICs) that resulted from computerized matching of non-TCL mass spectral peaks with a reference library of spectral peaks during the VOC and SVOC analyses. Data validation was performed by the USATHAMA Technical Support Division.

The data were evaluated by comparing the analytical results to historical data, QA data, Maximum Contaminant Levels (MCLs) and Secondary Maximum

Contaminant Levels (SMCLs). In addition to the MCL and SMCL values, two Action Levels (AL) are listed in the metals tables for copper and lead. The MCL or AL values are the enforceable primary drinking water standards promulgated under the Safe Drinking Water Act. SMCL values have been established for aesthetic and/or health reasons. These secondary levels represent reasonable goals for drinking water quality, but are not federally enforceable. In July 1991, the U.S. Environmental Protection Agency (EPA) adopted action levels for copper (1,300  $\mu\text{g/L}$ ) and lead (15  $\mu\text{g/L}$ ) that are applicable to public drinking water supplies and systems. This EPA action stipulates that if more than 10 percent of targeted tap samples collected from the water supply exceed the action level, then treatment of the system is required. Additional discussion of the analytical results in comparison to standards is provided at the end of the human health risk assessment in Section 2.5.6. The available standards are listed in the summary tables.

#### 2.3.2 Sources

The ASL is an active unlined facility that is impacting the water quality in the water-table aquifer. Refuse disposed in the landfill generally consists of mixed residential, commercial, and nonhazardous industrial waste. However, hazardous materials such as petroleum waste, oil, lubricant products, contaminated soil excavated from UST sites, and pesticides have reportedly been disposed in the landfill.

A portion of the northern area of the landfill was formerly used as a sludge mixing area. Digested sewage sludge was dried in the area and the dried sludge cake mixed with leaves and soil to form compost.

Leachate seeps have been noted primarily around the Cell 1 boundary.

The MDE landfill operating permit expired in June 1990 and a project is being conducted separate from this study to develop a closure plan for the facility.

#### 2.3.3 Surficial Soil

Three surface soil samples (SS-29, SS-30, and SS-31) were collected for analysis around the ASL. These samples were collected from a depth of 0-6 in. to characterize surficial soil chemistry and to use the data in the risk assessment. Tables 2.3-1 and 2.3-2 provide a summary of the data obtained from the analysis of these samples.

SS-29 was collected north of the landfill along the utility powerline topographically uphill from most of the landfill. SS-30 was collected west



of the landfill behind the landfill checkpoint in a wooded area. SS-31 was collected topographically downhill along the southern landfill boundary.

There were no volatile organic compounds detected in any of these three samples except for 2-butanone (8.16  $\mu\text{g/g}$ ) in the SS-29 sample. This compound was not detected in the trip or field blank samples associated with this sampling event, but there is a possibility that the source of this compound is associated with laboratory procedures.

No semivolatile organic compounds were detected in any of these samples.

Six pesticides were detected at low levels in the SS-29 sample, and two pesticides were detected at low levels in the SS-30 sample. All of these reported values are slightly above the certified reporting limit (CRL). As stated previously, SS-29 was collected along a utility powerline, and the detection of these pesticides could be associated with the use of pesticides along this utility line to control vegetation. SS-30 was collected in a wooded area where pesticide use would be expected to be minimal. The low levels of pesticides for both of these samples is not thought to be a cause for concern.

The metals data for these samples is provided in Table 2.3-2. A comparison of these metals values to a published range of background metals values indicated that there were no elevated metals values detected in these samples.

#### 2.3.4 Surface Water and Sediment

Six surface water and sediment samples were collected from the surface waterbodies located in the vicinity of the ASL (Plate 1). Five of the six samples were collected to the west of the ASL in the small streams that flow from east to west and originate close to the western boundary of the ASL. The sixth sample (SW/SS-7) was collected from a small, shallow ponded area along the eastern boundary of the ASL. The analytical results obtained from the analysis of the water samples are provided in Tables 2.3-3 and 2.3-4.

The surface waters in this area, which drain into the Little Patuxent River about 0.1 mi east of the reservation boundary (Figure 1.2-4) are classified by the State of Maryland as Use I, Water Contact Recreation and Protection of Aquatic Life. Water quality criteria applicable to freshwater Use I streams are summarized in Table 2.3-5. Criteria are listed for those trace metals and inorganics for which the water samples were tested and for the trace organics that were detected in the sampling program.

With only one sample from each station, the concentration data can be strictly compared only against the acute criteria for the protection of life, which represent maximum values not to be exceeded in any sample. The chronic and human health criteria are correctly compared against average concentrations measured over some period of time.

For all the tested parameters, there were no cases where the measured concentrations exceeded the acute criterion.

Those samples where the single concentration value exceeded the chronic aquatic life or human health criteria are listed below. Further sampling would be required to determine if a potential long-term water quality problem is present.

<u>Parameter</u>	<u>Chronic Aquatic Life Criterion</u>	<u>Human Health Criterion</u>
DDT	SW-2, 3, 5	SW-2, 3, 5
Aldrin		SW-3
Heptachlor	SW-4, 6	SW-4, 6
Aluminum	SW-2, 4, 5, 6, 7	
Arsenic		SW-2, 4, 7
Iron	SW-3, 4, 5, 6, 7	
Lead	SW-2	
Cyanide	SW-6	

EPA chronic criterion for aluminum should be applied against acid-soluble aluminum data, whereas total aluminum was determined in this sampling program. Total aluminum measures a significant portion of clay-bound aluminum that is not biologically available, so the results here probably overstate any possible toxic effect from aluminum. The human health criterion for arsenic is for the trivalent species, whereas total arsenic was measured here. It is common for natural water concentrations of total arsenic to exceed the human health criterion for trivalent arsenic.

The results of the sediment sample analyses are presented in Tables 2.3-6 and 2.3-7. There are no state or federal criteria to compare with these concentrations. Generally, though, the sediment samples fall into two groups: (1) SS-2, SS-3, and SS-7, which have relatively high concentrations of total organic carbon (TOC) (56-149 mg/L), aluminum (15-28 mg/L), and other metals; and (2) SS-4, SS-5, and SS-6, which have substantially lower concentrations of TOC (11-14 mg/L), aluminum (1.9-2.5 mg/L), and metals. Semivolatile organics were detected only at SS-2, and more pesticides were detected at SS-2 and SS-7 than at the other stations. The relatively high TOC and aluminum results may indicate a higher clay and organic detritus content in samples SS-2, SS-3, and SS-7 than in the other samples. This could indicate that these samples



were collected in ponded areas where clay and detritus particles accumulate, whereas the other samples were collected in higher velocity areas where these lighter particles are flushed away. The high affinities of carbon for trace organics and of clay particles for metals could explain the higher concentrations of the trace substances in samples SS-2, SS-3, and SS-4.

#### 2.3.5 Ground Water

The ground-water data included in this report were collected during March and April 1991. Samples were collected from the existing monitoring well network, which consists of 20 shallow and 6 deep monitoring wells. The shallow monitoring wells are completed in the water-table aquifer (upper Patapsco). The deep wells at the site are completed in the uppermost confined aquifer (lower Patapsco). Two additional deep wells, located approximately 1,000 ft south of the landfill, were also sampled. One of these samples was collected from well PW-6, a potable water supply well that is part of the FGGM water supply network. The other sample was collected from an observation well (AA-Cc40) that was installed by the U.S. Geological Survey (USGS) in the lower Patapsco aquifer as part of a regional ground-water monitoring network. PW-6 is completed in the Patuxent Formation between 500 and 700 ft below grade. Sampling locations for all monitoring points except for PW-6 are shown in Plate 1.

All of these samples were analyzed for the TCL and TAL. The data obtained from these tests are organized by aquifer and parameter group in this section.

##### Upper Patapsco

The TCL data obtained from the analysis of the samples collected from the upper Patapsco wells are listed in Table 2.3-8 and show that VOCs were reported in 17 of the 20 samples collected. The compounds detected included benzene, toluene, ethylbenzene, and xylenes (BTEX); chlorobenzene; chloroform; 1,1-dichloroethane; 1,2-dichloroethene; 1,2-dichloropropane; tetrachloroethene; trichloroethene; 1,3-dimethylbenzene; dichlorobenzene; methylisobutyl ketone; and trichlorofluoromethane. Table 2.3-9 shows the frequency of detection for VOCs by well. This table shows that benzene was detected in thirteen samples, ethylbenzene in eight samples, toluene in eight samples, xylenes in eight samples, and dichlorobenzene in six samples. All other compounds were detected in three wells or less. The highest number of compounds detected at a particular well was seven compounds, which occurred in the samples from MW-9, MW-14, and MW-12S. MW-9 is located along the western boundary of Cell 1. MW-12S and MW-14 are located along the southeastern boundary of Cell 1.



Figure 2.3-1 shows the distribution of total VOCs reported in the ground-water and leachate samples. This figure shows that the highest total VOC level was detected in the MW-15 sample (296.27  $\mu\text{g/L}$ ). The components of this total include benzene (4.57  $\mu\text{g/L}$ ), toluene (7.60  $\mu\text{g/L}$ ), ethylbenzene (75.0  $\mu\text{g/L}$ ), xylenes (88.1  $\mu\text{g/L}$ ), and 1,3-dimethylbenzene (121.0  $\mu\text{g/L}$ ). This well is located downgradient and very near the active Cell 2 area. The total VOC values in the closest downgradient well are significantly lower than the MW-15 total and range from 9.82  $\mu\text{g/L}$  at MW-8 to 32.7  $\mu\text{g/L}$  at MW-7S.

The associated field blank data (Table 2.3-8) includes very low levels of eight VOCs. This field blank sample was included in the same analytical lot as the MW-15 sample and was the sample that was tested immediately following the MW-15 sample. Four of the eight VOCs (benzene, toluene, ethylbenzene, and xylenes) were detected in the field blank and the MW-15 sample. All of the compounds detected in the field blank were reported at levels slightly above the CRL or detection limit. The presence of these compounds in the field blank data is probably associated with instrument contamination.

The next highest total VOC level (114.69  $\mu\text{g/L}$ ) was reported from the analysis of the MW-9 sample. This well is located along the western Cell 1 boundary, and the data from the closest downgradient well (MW-8) showed a significantly lower total VOC level (9.82  $\mu\text{g/L}$ ) compared to MW-9.

The area between MW-9 and MW-15 and the closest downgradient wells (MW-5, MW-6, and MW-7S) consists of marshy areas with emergent surface streams. These surface streams are probable discharge points for the water-table aquifer in this area, thus influencing the migration of contaminants in the ground-water flow regime to the west. However, the overall extent to which these surface streams are limiting ground-water contaminant migration west of MW-6, MW-7S, and MW-8 is not known.

Along the southern boundary, seven shallow wells were sampled. The highest total VOC values for these wells were detected in the MW-1 (31.47  $\mu\text{g/L}$ ) and MW-12S (35.02  $\mu\text{g/L}$ ) samples. MW-1 is located south-southwest of the central Cell 1 area, and MW-12S is located due south of the central Cell 1 area. There are no wells located downgradient of MW-1, so the extent of the contamination in this area is not known. MW-21 is cross-gradient from MW-1 and parallel to MW-1 relative to the Cell 1 boundary. The total VOC level detected in the sample from this well was 1.0  $\mu\text{g/L}$ , which is significantly lower than MW-1. MW-20 is located south and downgradient of MW-12S, and there were no volatiles detected in the sample from this well. This suggests that the migration of the contaminants detected in MW-12S is limited in the direction of MW-20 or that there is a more preferred ground-water flow path in the area of MW-12S that is not in line with MW-20.



Six wells were collected from along the eastern boundary. The proximity of the ASL to the eastern boundary restricted the placement of monitoring wells to the east. The highest total VOC levels were reported in the samples collected from MW-14 (65.27  $\mu\text{g/L}$ ) and MW-19 (53.46  $\mu\text{g/L}$ ), both of which are located along the southeast boundary of Cell 1. The next highest total VOC value was reported in the MW-13 (29.03  $\mu\text{g/L}$ ) sample. MW-13 is located east of the active Cell 2 area.

A comparison of the VOC data from the shallow wells to drinking standards indicates that the levels of benzene reported in four wells exceed the benzene drinking water standards. The benzene levels of four other samples were just slightly under the standard. The locations of the wells and the relative benzene levels are shown in Figure 2.3-2. Three of the four wells (MW-12S, MW-16, and MW-19) that produced exceedance values are located along the south-southeast boundary of Cell 1. The other well (MW-9) is located along the western boundary of Cell 1.

Pesticides were detected in 16 of the 20 samples collected from the upper Patapsco wells. The sample collected from MW-4S, the upgradient well, was one of the samples in which no pesticides were detected. The other samples that did not test positive for pesticides included MW-5, MW-20, and MW-21. MW-5 is located west of active Cell 2 and south of inactive Cell 3, and MW-20 and MW-21 are located along the southern and southeastern boundaries, respectively.

None of the pesticide values exceeded the respective MCL; however, the lindane value reported for the MW-17 sample equaled the MCL of 0.20  $\mu\text{g/L}$ . MW-17 is located along the northeastern ASL boundary. Because the ground-water flow direction in this area is in a westerly direction toward the landfill, the source of this pesticide is possibly due to surface application of pesticides.

The pesticide data indicate that the ASL is a source of pesticide contamination in the water-table aquifer. The extent of this contamination is as prevalent as the VOC contamination, although the levels of the pesticides detected are generally lower than the regulatory criteria. Further monitoring for pesticides is warranted based on these data.

Total and dissolved metals data for the upper Patapsco wells are provided in Tables 2.3-10 and 2.3-11, respectively. These tables also list the MCL, SMCL, and AL for the parameters. There are no total and dissolved metals values above the respective MCL or AL, except for the total lead value reported for the MW-15 sample. The total lead value (18.3  $\mu\text{g/L}$ ) for the MW-15 sample was only slightly over the AL of 15  $\mu\text{g/L}$ . There was no dissolved lead detected in the filtered MW-15 sample.

Total aluminum (132 to 20,700  $\mu\text{g/L}$ ), iron (216 to 195,000  $\mu\text{g/L}$ ), and manganese (106 to 1,230  $\mu\text{g/L}$ ) values generally exceed the SMCL criteria for almost all of the samples. The SMCL for aluminum is stated as a range from 50 to 200  $\mu\text{g/L}$ ; the SMCLs for iron and manganese are 300 and 50  $\mu\text{g/L}$ , respectively.

Dissolved aluminum values exceed the SMCL range in only three samples: MW-1 (2,090  $\mu\text{g/L}$ ), MW-4S (1,110  $\mu\text{g/L}$ ), and MW-5 (354  $\mu\text{g/L}$ ). All of the dissolved iron values (ND-146,000  $\mu\text{g/L}$ ) exceed the SMCL, except for the upgradient well sample, MW-4S. The dissolved iron value for this well sample was below CRL (77.5  $\mu\text{g/L}$ ). All of the dissolved manganese values (98.7-1,160  $\mu\text{g/L}$ ) exceeded the SMCL, including the MW-4S value.

The published literature on the natural water quality of this area indicates that iron levels are typically high in the water samples from Anne Arundel County. The iron content of 192 samples collected from Anne Arundel County ranged from 0.00 to 32,000  $\mu\text{g/L}$ . The manganese content of 69 samples collected from Anne Arundel County ranged up to 430  $\mu\text{g/L}$  (MGS Bulletin 26). Given this range of values and the fact that the metals data in this report were obtained from the analysis of monitoring well samples, not drinking water wells, these excessive metals values are not unexpected. This is not to say that the ASL is not an additive source of metals, but that it is difficult to ascertain the level of influence that the ASL has on these parameters given the high regional background levels.

#### Lower Patapsco

Table 2.3-12 provides the organic data obtained from the analysis of ground-water samples collected from the confined lower Patapsco aquifer. Six of these wells were installed by EA and located next to a shallow monitoring well to form a two-well cluster. MW-4D was installed as the upgradient well for this aquifer. The well designated AA-Cc40 was installed by the U.S. Geological Survey as part of a regional monitoring network. This well is located approximately 2,500 ft south of the landfill. It is completed in the lower Patapsco aquifer at a total depth of 238 ft below grade.

The TCL data obtained from the analysis of these samples indicate that there were no VOCs detected in the samples collected from the wells that were installed by EA in the lower Patapsco aquifer in proximity to the ASL. Very low levels of toluene (1.60  $\mu\text{g/L}$ ) and a tentatively identified compound (1,3-dimethylbenzene, 1.11  $\mu\text{g/L}$ ) were reported in the AA-Cc40 sample. Both of these levels are slightly above the CRL (toluene CRL = 1.36  $\mu\text{g/L}$ ) and the instrument detection limit, and are not thought to be attributable to the ASL.



A semivolatile organic compound, bis(2-ethylhexyl)phthalate (76.2  $\mu\text{g/L}$ ), was detected in the MW-7D sample. Because this compound is a common laboratory contaminant, it is probable that detection of this compound is not attributable to the ASL.

A number of pesticides were detected in all of the samples collected from these deep wells, including the upgradient well. None of these values exceed any of the regulatory criteria. The detection of pesticides in the upgradient well MW-4D suggests that the ASL may not be the source of the pesticides in the lower Patapsco. Although concern exists for pesticide contamination in the water-table aquifer, the continuous middle confining layer is thought to effectively restrict vertical migration of contaminants from the water-table aquifer into the lower Patapsco. This is evidenced by the lack of volatile organic contamination in samples from this aquifer. Given these hydrogeologic conditions and the detection of pesticides in the upgradient well, a level of uncertainty exists in regards to whether the pesticide data detected in the lower Patapsco samples are attributable to the ASL and are a cause for concern.

Total and dissolved metals data obtained from the analysis of samples collected from the lower Patapsco wells are provided in Tables 2.3-13 and 2.3-14. These data indicate that there are no total or dissolved arsenic, copper, chromium, cadmium, mercury, selenium, silver, and zinc values that exceed the respective MCL or SMCL.

Total aluminum values (279 to 3,970  $\mu\text{g/L}$ ) generally exceed the SMCL range. Three of the seven lower Patapsco samples (MW-4D, MW-7D, and AA-Cc40) had dissolved aluminum values that exceeded the SMCL range. The highest dissolved aluminum was detected in the sample collected from MW-4D, the upgradient well. This suggests that these high dissolved aluminum levels are typical of the water quality in this aquifer and are not associated with the ASL.

The total lead value detected in the sample from AA-Cc40 (47.6  $\mu\text{g/L}$ ) was the only value above the Action Level (AL) for lead. There were no dissolved lead values exceeding the AL criteria.

All of the total iron values, except for the MW-7D value, exceed the SMCL for total iron. Only two of the seven samples (MW-10D and AA-Cc40) reported dissolved iron values in excess of the SMCL. As discussed previously, the elevated iron concentrations are a common problem in this area and are not unexpected.

The total and dissolved manganese values detected in the MW-10D and AA-Cc40 samples were the only values that exceeded the SMCL.

#### 2.3.6 Leachate

Three leachate samples were collected from around the perimeter of Cell 1 near the toe of the slope for the 2-ft lifts of waste (Plate 1). L-1 was collected along the western boundary next to MW-9. L-2 and L-3 samples were collected from along the southern and eastern boundaries of Cell 1, respectively. These samples were collected as grab samples and analyzed for the full TCL and total metals on the TAL. The data obtained from the analysis of these samples are shown in Tables 2.3-15 and 2.3-16. The analytical results for sample L-1 showed the presence of three VOCs: benzene (4.40  $\mu\text{g/L}$ ), ethylbenzene (4.20  $\mu\text{g/L}$ ), and total xylenes (39.00  $\mu\text{g/L}$ ). VOC levels detected in the L-2 sample included similar compounds: chlorobenzene (6.80  $\mu\text{g/L}$ ), ethylbenzene (7.20  $\mu\text{g/L}$ ), and toluene (5.90  $\mu\text{g/L}$ ). One volatile organic compound, ethylbenzene at 1.90  $\mu\text{g/L}$ , was detected in the L-3 sample.

Five SVOCs, 1,3-dichlorobenzene, 2,4-dimethylphenol, diethyl phthalate, naphthalene, and p-chloro-m-cresol, were detected in the L-1 sample. One SVOC was detected in L-2 and L-3.

Nine pesticides were detected in the L-2 sample (Table 2.3-15). Three pesticides were detected in the L-1 sample, and four pesticides were reported in the L-3 sample. Similar pesticide compounds and levels were reported in the ground-water samples collected from the wells located in proximity to the leachate samples.

A comparison of the total metals data obtained from the analysis of these samples indicates that the L-1 metals data exhibited the highest concentration for all of the metals. Some of the same trends are noted (high aluminum, iron, and manganese) in these data in comparison to the total metals data obtained from the upper Patapsco wells.

#### 2.3.7 Soil Gas Monitoring

Passive and active soil gas monitoring was conducted at the sanitary landfill. The active monitoring parameters included methane, aromatic hydrocarbons, and chlorinated aliphatic hydrocarbons results.

Figure 2.3-3 shows the location of the active and passive monitoring points within the study area. A perimeter grid network was set up to encircle the general permitted area. In addition, monitoring points were placed over the entire inactive Cell 1 area at 200-ft intervals. No active monitoring was conducted inside of the perimeter grid network in Cell 1 or 2. The future placement of a cap on Cell 1 initiated the need for obtaining information on top of Cell 1.



### Active Soil Gas Monitoring

The active soil gas monitoring was conducted between 3 and 31 October 1990 and on 12 November 1990. The field procedure involves installing soil gas sampling probes into the subsurface in a grid pattern that will meet the data objectives. A sampling manifold and vacuum source is then attached and a soil gas sample is obtained by actively withdrawing the soil gas from the subsurface. The sample is then analyzed onsite by gas chromatography. The results from the analysis can then be plotted graphically to show isoconcentration contours. Soil gas monitoring is capable of delineating subsurface contamination where the mechanism for the contamination is gaseous phase transport. A more detailed explanation of the soil gas monitoring procedure is provided in Appendix A.2.

A total of 131 soil gas sampling points were tested, with soil gas samples being collected at an average depth of 5 ft.

Soil gas sample locations VP-1 to VP-68 were located at 200-ft intervals around the perimeter of Cells 1, 2, and 3. The sample points were primarily located within 50 ft of the fill area. The actual distance was dependent on surface restrictions, e.g., dense vegetation. Four of the 68 soil gas sampling points placed along the boundary were soil gas vertical profiles to 8 ft, i.e., VP-3, VP-4, VP-10, and VP-61. A soil gas vertical profile involves sampling and analyzing the soil gas at various depths at one sampling location. This provides information as to any difference in contaminant concentrations in the vertical horizon. If soil gas contaminant concentrations vary by an order of magnitude from one sampling depth to another, the sampling scheme is adjusted such that subsequent samples are collected in the vertical horizon with the highest concentration. No significant concentration differences were noted as a result of the vertical profiling.

Forty-two sampling points (VP-69 to VP-111) were located in a 200-ft grid network inside the Cell 1 perimeter grid. Two of these sample locations, VP-80 and VP-103, were vertical profiles to 8 ft.

In general, the soil gas samples VP-1 to VP-111 were obtained under low vacuum conditions. This indicates a relatively free movement of soil gas throughout the subsurface. Soil gas samples were unable to be obtained in portions of the western edge of Cell 1. This was due to perched water and/or low permeability soil conditions. Because no data were obtained, these sampling locations are not included in the results table or site maps.

## Methane

Methane results are included in Table 2.3-17. Figure 2.3-4 depicts the grouping of the elevated methane concentrations encountered. Methane concentrations ranged from below the instrument detection limit (2.0 ppm) to 290,000 ppm. All sampling locations generally contained detectable levels of methane gas except for VP-36 to VP-41, which were located northwest of Cell 3. The methane concentrations generally exceeded 10,000 ppm. The lower explosive limit (LEL) of methane is approximately 5 percent or 50,000 ppm. "Elevated methane concentrations" are considered to be those concentrations in excess of 25,000 ppm or one-half of the LEL.

The data obtained from the sampling points (VP-7 to VP-23) located along the southern and eastern boundaries of Cell 1 accounted for the largest contiguous areas of "elevated methane concentrations" across the site. The highest methane concentrations (greater than 200,000 ppm) were detected along the western boundary of Cell 2 (VP-51, VP-52, VP-54, and VP-55) and northeast of Cell 3 (VP-27 to VP-30).

The elevated methane concentrations and potential closure of Cell 1 prompted the placement of VP-69 to VP-111 in a 200-ft grid network over the entire Cell 1 area.

The methane concentrations encountered throughout the Cell 1 area ranged from below the instrument detection limit (2.0 ppm) to 94,000 ppm, with the average being approximately 42,000 ppm. As Table 2.3-17 shows, very few of the Cell 1 vapor points possessed methane concentrations below the detection limit and, in general, most methane concentrations were above 10,000 ppm. This figure is by no means inordinate, given the nature of the project site.

Cell 2 is the only currently active area of the landfill. A second 10-ft lift over Cell 2 is proceeding from east to west. Part of these activities include the spreading, aerating, and subsequent mixing of treated sewage sludge and petroleum-contaminated soils. The elevated methane concentrations along the southeast and western boundaries of Cell 2 is consistent with these activities.

The majority of Cell 3 has remained inactive since approximately 1976. Therefore, the production and subsequent migration of landfill gas within this area probably ceased a number of years ago. The elevated methane concentrations encountered at VP-28 to VP-30 may be a result of the production of landfill gas by bacterial degradation of waste leachates in the adjacent unsaturated zone. The source of these leachates is probably waste wood chippings stockpiled in the immediate area.



Partitioning of volatile contaminants from ground water is a source of soil gas contamination above the water table. Some of the principal factors controlling the volatile organic composition of soil gas are the concentration gradients at the water table and capillary fringe and the ratio of diffusion coefficients in the saturated and unsaturated zones. This seems to be another factor that could contribute to the elevated methane concentrations noticed in the vapor points located around the Cell 1 boundary (i.e., closer to the water table) and particularly to areas located further away from the main landfill body, where mass flow transport mechanisms are less effective.

### Hydrocarbons

Table 2.3-17 presents the hydrocarbon results. Figure 2.3-5 depicts the distribution of pre-benzene concentrations. Unlike methane, significant hydrocarbon contamination of the landfill gas is not a product of the natural decomposition process of landfills. However, hydrocarbon contamination was detected in certain areas.

A general indicator for volatile low molecular weight hydrocarbons is the sum of the compounds eluting prior to benzene in a chromatographic analysis, or "pre-benzene" compounds. These compounds are not identified individually but are normalized to the toluene analyte.

Pre-benzene compounds comprised the most significant and numerous contributions to the hydrocarbon contamination of the landfill gas. The maximum pre-benzene concentration encountered at the landfill was 1,000 ppm (VP-4, 8 ft), with the average being approximately 22 ppm. Figure 2.3-5 reveals that the most numerous incidences of pre-benzene compounds occurred in the northern section of Cell 1. Within this area, the vapor points located on top of the cell generally produced higher pre-benzene concentrations than those located around the boundary of the cell. Therefore, unlike methane, the most numerous incidences of pre-benzene contamination did not occur along the landfill boundary itself. In general, when pre-benzene compounds were encountered, the levels detected were not indicative of significant hydrocarbon contamination and did not necessarily correspond with detectable levels of benzene, toluene, ethylbenzene, and xylene (BTEX).

BTEX were encountered less frequently and generally in lower concentrations than pre-benzene compounds. Only two soil vapor samples (VP-78 and VP-90) yielded detectable levels (greater than 0.1 ppm) of benzene. Similar results occurred for ethylbenzene, for which the highest concentration detected was 10 ppm at VP-10. Toluene and xylenes, however, were encountered more

frequently and in higher concentrations. The highest toluene concentration was encountered along the western boundary of Cell 1 at VP-61 (110 ppm). This was the only incidence of a toluene concentration in excess of 100 ppm.

In general, the toluene concentrations encountered were below 20 ppm. The highest total xylene concentration encountered was 32 ppm at VP-10, with the remaining detectable levels being generally lower than 10 ppm. Although the toluene and xylene concentrations are not indicative of significant hydrocarbon contamination, they were encountered more frequently than benzene or ethylbenzene. One possible explanation for this is the known disposal of soils contaminated with No. 2 fuel oil in the landfill area.

Overall, the hydrocarbon contamination detected in the landfill gas produces no cause for concern. The concentrations encountered are not indicative of significant petroleum-based hydrocarbon contamination, and, unlike that of methane, the distribution of elevated concentrations does not indicate that lateral migration of hydrocarbon-contaminated vapors is occurring.

#### Chlorinated Hydrocarbons

Table 2.3-18 presents the chlorinated aliphatic hydrocarbon analysis results. Figures 2.3-6 and 2.3-7 depict the distribution of methylene chloride and tetrachloroethene concentrations.

Of the seven chlorinated aliphatic hydrocarbons, methylene chloride (MC) was the most dominant in virtually all the soil vapor samples analyzed. The remaining six chlorinated hydrocarbons are, in order of decreasing concentration levels, tetrachloroethene (PCE), trans-1,2-dichloroethene (t-DCE), trichloroethene (TCE), 1,1,1-trichloroethane (TCA), cis-1,2-dichloroethene (c-DCE), and carbon tetrachloride (CT).

The maximum MC concentration encountered was 450 ppm at VP-51, and as Table 2.3-18 indicates, the majority of vapor samples obtained possessed detectable levels of MC. Figure 2.3-6 indicates that of these levels, those greater than 1 ppm were generally located along the western boundaries of Cells 1 and 2 and on the northern portion of Cell 1 itself. These figures also indicate that instances of MC concentrations in excess of 10 ppm were not a norm; rather, they were generally confined to specific areas on top of Cell 1 itself and not along the boundaries. Certain areas along the landfill boundary did possess elevated MC concentrations (e.g., VP-8, 150 ppm; VP-51, 450 ppm); however, these areas appear isolated in nature with adjacent points being significantly lower in MC concentration. The occurrence of the remaining chlorinated aliphatic hydrocarbons (exemplified by PCE) shown



in Figure 2.3-7 did not necessarily correlate with the distribution of MC concentrations; however, they do significantly overlap in the northern portion of Cell 1.

The maximum PCE concentration encountered was 30 ppm at VP-14. Table 2.3-18 reveals that PCE was far less prevalent in the soil vapor samples than MC. The majority of instances in which detectable PCE concentrations occurred was in those soil vapor samples obtained from along the eastern boundary and northern section of Cell 1 (Figure 2.3-7). Detectable PCE levels were not encountered along the western boundaries of Cells 1 and 2. In general, the PCE concentrations detected were below 1 ppm. Although Figure 2.3-7 may indicate a greater potential for lateral soil vapor advection of PCE out of the property boundary, this migration, if occurring, should have limited impact potential.

The remaining chlorinated aliphatic hydrocarbons detected in the soil vapor exhibited a similar distribution pattern to that of PCE in that the most numerous incidences of detection generally occurred toward the northern section of Cell 1. Outside of this area, isolated incidences of detectable chlorinated contamination do occur, but they are of less significance due to their random nature. The maximum concentrations encountered in each case are as follows:

trans-1,2-dichloroethene	VP-109, 30 ppm
trichloroethene	VP-14, 10 ppm
1,1,1-trichloroethane	VP-97, 5.9 ppm
cis-1,2,-dichloroethene	VP-14, 35 ppm

#### Passive Soil Gas Monitoring

On 11 June 1991, 12 passive soil gas sampling badges, designated PS-1 to PS-12, were buried at the sanitary landfill in areas of elevated concentrations obtained during active soil gas sampling. Figure 2.3-3 depicts the passive soil gas sampling locations. On 25 June 1991, the 12 passive sampling badges were retrieved and submitted for laboratory analysis of VOCs using modified EPA Method 624. Table 2.3-19 presents the analysis results for analytes that were detected in the samples.

The contaminant concentrations presented in Table 2.3-19 are time weighted averages ( $\text{mg}/\text{m}^3/\text{day}$ ). These concentrations are representative of contaminant emission rates from the landfill area.

#### 2.3.8 Aquatic Resources

The methods used to characterize and evaluate the aquatic resources of the ASL site were the EPA Rapid Bioassessment Approach (Plafkin et al. 1989) for benthic invertebrate communities, and electroshocking and collection for fisheries evaluation. The specifics of the techniques used are detailed in Appendix A.9.

##### Benthic Invertebrate Sampling

The sampling stations located in the vicinity of the ASL are SLF1, SLF2, and RHB1 (Figure 2.2-8). Station SLF1 is located upstream of the landfill on a small stream with low flow. This station lacks a riffle/run and instead has a very silty, sandy bottom with limited cobble and gravel substrate. Station SLF2, downstream of SLF1 and adjacent to the landfill, has better habitat quality. This station has a good flow and substrate which should provide for a healthy benthic community. Due to the shallow depth and small channel at Station SLF1, Station RHB1 was sampled because it is located in an area unaffected by the landfill and has habitat conditions similar to Station SLF1. This station was not only selected as a comparison to SLF2, but was also used to characterize this stream.

A list of species collected from the landfill area including their abundance is presented in Table 2.3-20. A total of 34 different taxa were collected from the three stations in the landfill area. Total taxa at the stations ranged from 12 at SLF2 to 22 at SLF1. Diptera, mainly Chironomidae larvae (midges), comprised the largest number of taxa in a major group, with 17 of the 34 combined taxa collected. Trichoptera larvae (caddisflies) were found at all stations, and in high numbers at station RHB1. Ephemeroptera (mayflies) were absent from all stations, and Plecoptera (stoneflies) were only present at Station SLF2. Simulium larvae (blackflies) were abundant at Stations RHB1 and SLF2.

##### Physicochemical

Results of the onsite physicochemical parameters [temperature, pH, dissolved oxygen (DO), and conductivity] are presented in Table 2.3-21. These parameters were measured concurrent with the benthic samples. DO, temperature, and pH were similar at all stations in the landfill area. Conductivity was high at Station SLF1.



## Metrics

Metrics are measurements of various characteristics of the structure and function of the aquatic invertebrate community. Independently they provide information on characteristics of the community they represent. Together the metrics contribute to an integrated assessment of the biological condition of the community. The metrics were calculated from abundance data based on a 100-organism subsample. The scores from the ranking analysis are presented in two ways.

The first analysis is a total of all metric scores, while the second is a total of only three selected metrics: (1) Taxa Richness (number of species), (2) Ephemeroptera-Plecoptera-Trichoptera Ratio (EPT) (ratio of mayflies, stoneflies, and caddisflies, three types of aquatic insects), and (3) Hilsenhoff Biotic Index (HBI) (an index of pollution tolerance) (Figure 2.3-8). The second analysis represents a partitioning of the total set of metrics to provide a higher resolution analysis based on metrics known to be more strongly related to the diversity and sensitivity of the macroinvertebrate community. The remaining metrics represent a more variable component of the community, because functional feeding group strategies, which can vary by life stage, seasonality, and food availability, are integral to these metrics.

The maximum score of the three stations near the landfill, considering the total of all metrics, was 43 at Station SLF1 (upstream from the landfill). The lowest score (27) was obtained at Station SLF2 (downstream from the landfill). Station RHB1 was intermediate to these stations, with a score of 32. The totals of the three metrics exhibited a slightly different pattern. Station SLF1 had the maximum score (10), followed by SLF2 (9), and the lowest, RHB1 (7). Absolute value of these scores is not as important as their relative value. High scores represent better community attributes than low scores.

Metric 1, Taxa Richness (total number of different taxa), ranged from 12 taxa at SLF2 to 23 taxa at SLF1. The EPT index (Metric 2), which is the total number of distinct taxa within the groups Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies), was low with only 2 EPT at RHB1 and 3 EPT at SLF1 and SLF2.

Metric 3, the percent contribution of the numerically dominant taxon to the total number of organisms, uses the abundance of the numerically dominant taxon relative to the rest of the population as an indication of community balance at the species level. This metric ranged from 26 at SLF1 to 53 at SLF2.

The EPT/(EPT + Chironomidae) abundance ratio (Metric 4) uses relative abundance of the indicator groups Ephemeroptera, Plecoptera, Trichoptera, and Chironomidae as a measure of community balance. This metric ranges from 27 at SLF1 to 44 at RHB1. Station RHB1 scored the highest due to a fairly even distribution of organisms among all major groups.

The abundance of the Shredder Functional Group relative to all other individuals allows evaluation of potential impairment as indicated by the detritus-based shredder community. Shredder/Total (Metric 5) ranged from 19 at SLF2 to 36 at SLF1 and RHB1.

The Ratio of Scraper Functional Feeding Group to Scrapers Plus Filter Collectors (Metric 6) reflects the riffle/run community food base. Metric 6 values ranged from 1 at RHB1 to 18 at SLF1. Station RHB1 scored low because only one scraper was present at this station.

The HBI (Metric 7) considers the tolerance value of a taxon in conjunction with the number of organisms of that taxon. The HBI metric values ranged from 5.9 at SLF2 to 6.6 at SLF1.

The final metric, Hydropsychidae/Total Trichoptera (Metric 8), compares the dominance of the family Hydropsychidae to the total Trichoptera population. This metric was very high at all three stations due to the dominance of Trichoptera in the family Hydropsychidae. This metric ranged from 93 at SLF1 to 100 at SLF2 and RHB1.

#### Habitat Assessment

A summary of the habitat quality can be found in Table 2.3-22. Various habitat parameters (e.g., substrate particle sizes) are weighted to emphasize the most biologically significant parameters (Figures 2.3-9 and 2.3-10). The total habitat quality scores ranged from 52 at SLF2 to 79 at RHB1 (Table 2.3-22). Station SLF1 (upstream from the landfill) scored the lowest in habitat quality of all the stations due to low flow, lack of substrate, high degree of embeddedness, and channel alteration.

The relationship between habitat quality and biological condition among all stations is illustrated as a line graph. Ninety-five percent confidence intervals were calculated for the data around the regression line to obtain the expected range of values for biological condition given the level of habitat quality. In this manner, outliers can be readily identified and attributed to causes other than habitat limitations. The regression analysis was performed between habitat quality and the sum of all the metric scores as well as the sum of the three metrics alone to discern common trends in station



outliers. Stations SLF2 and RHB1 were consistent outliers in both graphs, while SLF1 has a higher biological condition than would be predicted. By virtue of being outliers to the norm, both stations would be considered to have a modified community structure and function.

### Assessment

The condition of biological communities and physical habitat quality are two interrelated factors relied upon to evaluate aquatic ecological situations. Station SLF1 upstream of the landfill was characterized by a much better benthic community than expected given the limited habitat at this station. However, SLF2, with a better habitat quality, had a benthic community indicative of a higher level of stress than evidenced at the upstream station due to the nearby landfill. However, Station RHB1, not influenced by the landfill and with a good habitat quality, did not exhibit the benthic community expected. This may be related to the influence of Soldier's Lake upstream of this station.

### Fisheries Investigation

#### Description of Sampling Stations

Station SLF1 was located on a small stream adjacent to the northwestmost extent of the ASL immediately downstream of the landfill road. The stream ranged in width from 4 to 8 ft, was generally shallow (less than 1 ft deep, with some areas up to 3 ft), and had a stream bottom composed primarily of sand. Station SLF1 could be characterized as a slow-flowing stream with little riffle or pool habitat available. There was evidence that the stream conveys substantial quantities of sediment from upstream sources during rainfall events, contributing to the limited available fish habitat.

Station SLF2 was located downstream of SLF1 below the confluence of a small stream draining the ASL. This site was characterized by diverse fish habitat in the form of riffles, pools, and instream woody debris. Substrates varied from small and large gravel in the riffles to sand and silt in the deeper pools.

Station RHB1 was located on Rouge Harbor Branch downstream of Soldier's Lake Dam and was similar in appearance to Station SLF2. Station RHB1 was characterized by riffle, run, and pool habitat and by fish habitat in the form of undercut banks, overhanging vegetation, instream woody debris, and pools with depths up to 4 ft. Substrates varied from large gravel and small cobble in the riffles to sand and silt in the deeper pools.

## Results of Fish Investigations

A total of 143 fish representing 16 species and 7 families were collected from three stream stations near the Fort Meade Active Sanitary Landfill (Table 2.3-23). The most common species collected at each of the three sites were members of the sunfish family--pumpkinseed (n = 58), bluespotted sunfish (n = 21), and bluegill (n = 21) (Table 3-12). These species typically occur in slow-moving streams and impoundments of Piedmont and Coastal Plain regions along the Atlantic slope (Lee et al. 1980). Many of the other species collected are considered common inhabitants of Coastal Plain fish assemblages including American eel, eastern mudminnow, redbfin pickerel, and creek chubsucker (Lee et al. 1980). All 16 species had been previously reported from the Patuxent River drainage [Patuxent Wildlife Research Center (PWRC) 1979; Maryland Department of Natural Resources (MDNR) 1985].

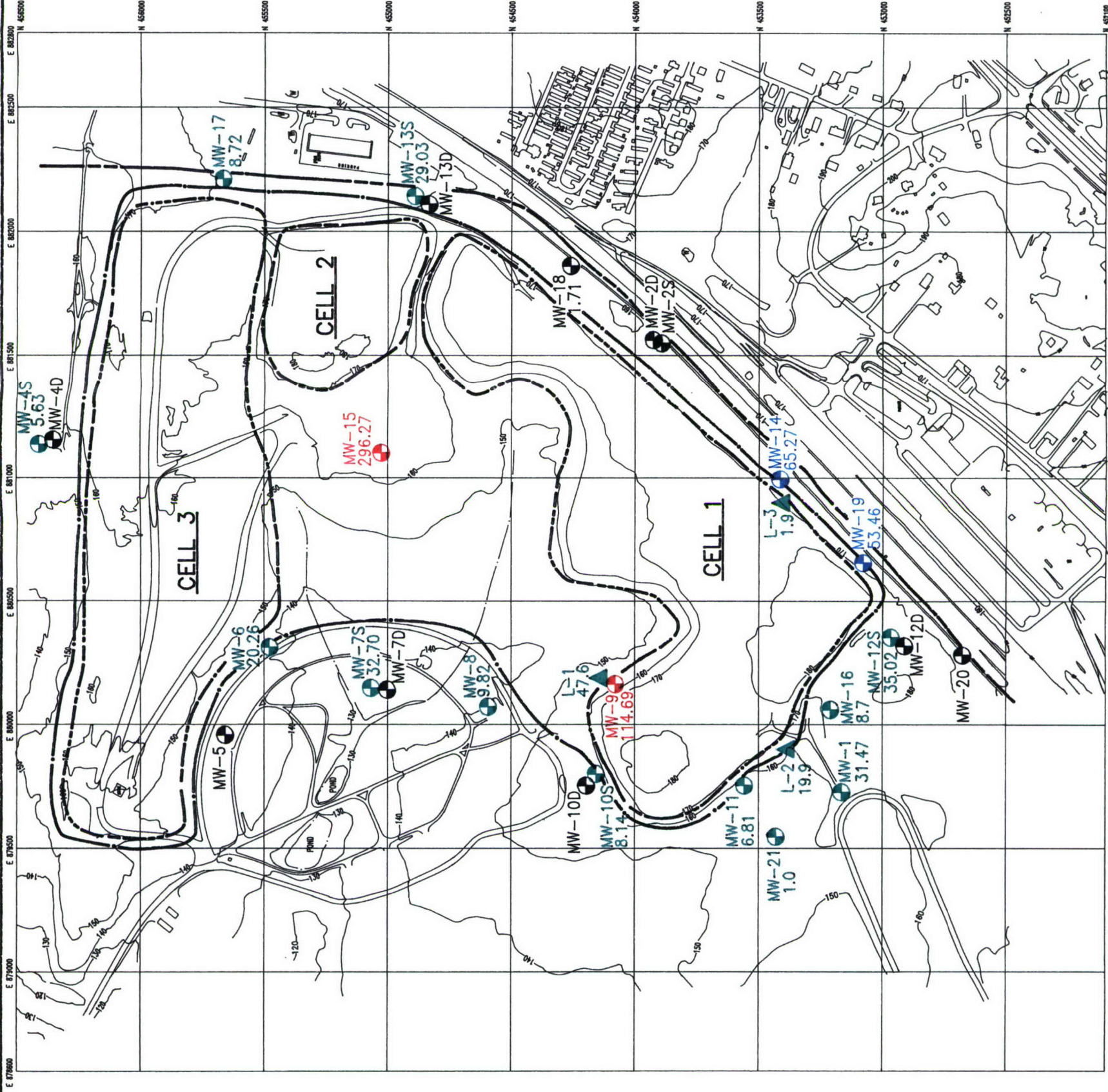
The total number of species was highest at stations RHB1 (n = 11) and SLF2 (n = 8) and lowest at station SLF1 (n = 4). These differences appeared to be due to habitat differences between the stations and the proximity of Station RHB1 to the spillway of Soldier's Lake Dam. Station SLF1 was located on a small headwater stream upstream of a ponded wetland area and provided sufficient habitat for small stream fishes such as juvenile pumpkinseed, eastern mudminnow, and blacknosedace. Station SLF2, located downgradient of the ASL, had a fish assemblage similar to that of Station RHB1. Fish communities at Stations SLF2 and RHB1 were dominated by sunfishes--bluespotted, redbreast, pumpkinseed, and bluegill. Swallowtail shiner, which are considered to be a clean-water species by Tsai (1968), were collected only at Station RHB1. It appears that the slightly greater number of species at Station RHB1 was a function of better fish habitat and the proximity to Soldier's Lake. The stocking of bluegill, largemouth bass, and catfish in Soldier's Lake could account for their presence below the spillway at RHB1.

Incidences of external parasitism and other anomalies were more apparent at Station SLF2 than at Stations SLF1 and RHB1 (Appendix A.9.2). At Station SLF2, 40 percent of redbreast sunfish and 38.5 percent of bluegill sampled were affected by external parasites (e.g., leeches) or other surface anomalies (Appendix A.9.2). Other sunfish species--bluespotted (9.1 percent) and pumpkinseed (less than 1 percent) collected at Station SLF2 showed a lower incidence of parasitism and surface anomalies. No other species collected at Station SLF2 showed any signs of poor health or stress. Incidences of external parasitism and other anomalies were not apparent at Stations RHB1 and SLF1 (Appendix A.9.2).



While the quality of the water draining the ASL might be sufficiently degraded to cause stress and health effects, as evidenced by an increased incidence of external parasitism, it does not appear to be sufficiently degraded to affect the types of fishes occurring downstream at Station SLF2. Fish communities occurring in areas with degraded water quality often show higher incidences of poor health such as parasitism, tumors, fin damage, discoloration, and hemorrhaging (Karr et al. 1986). Although manifestations of poor health are generally more common in degraded habitats, a low incidence of anomalies would be expected even in pristine areas (Karr et al. 1986). Despite possible indications of poor health, the fish community at Station SLF2 was similar in species composition to nearby Station RHB1, which did not receive drainage from the ASL. Furthermore, water quality leaving the landfill may be improved somewhat prior to Station SLF2 because it passes through both wetland and ponded areas and is diluted further by input from the stream draining Station SLF1.





N

## LEGEND

- APPROXIMATE LIMIT OF PERMITTED LANDFILL AREA
- FORT MEADE RESERVATION BOUNDARY
- APPROXIMATE LANDFILL CELL BOUNDARY
- TOPOGRAPHIC CONTOUR IN FEET ABOVE MSL

MW-16  
8.7  
MONITORING WELL  
TOTAL VOLATILE ORGANIC DATA

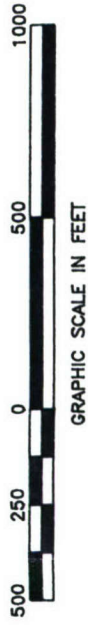
L-2  
19.9  
LEACHATE SAMPLE  
TOTAL VOLATILE ORGANIC DATA

## COLOR CODING SCHEME

- ND (NOT DETECTED) TOTAL VOLATILE ORGANIC DATA
- >ND - 50 ug/l TOTAL VOLATILE ORGANIC DATA
- 50 - 100 ug/l TOTAL VOLATILE ORGANIC DATA
- 100 - 300 ug/l TOTAL VOLATILE ORGANIC DATA

## NOTES

- CELL 1 AND 2 BOUNDARY OUTLINES AREA WHERE 2-10 FT. LIFTS HAVE BEEN PLACED OVER TRENCH FILL AREA.
- CELL 3 BOUNDARY DEPICTS APPROXIMATE EXTENT OF TRENCH FILL AREA.
- DASHED GROUND-WATER CONTOUR LINES INFERRED FROM SURFACE TOPOGRAPHY.
- CHEMICAL DATA UNITS: ug/l.



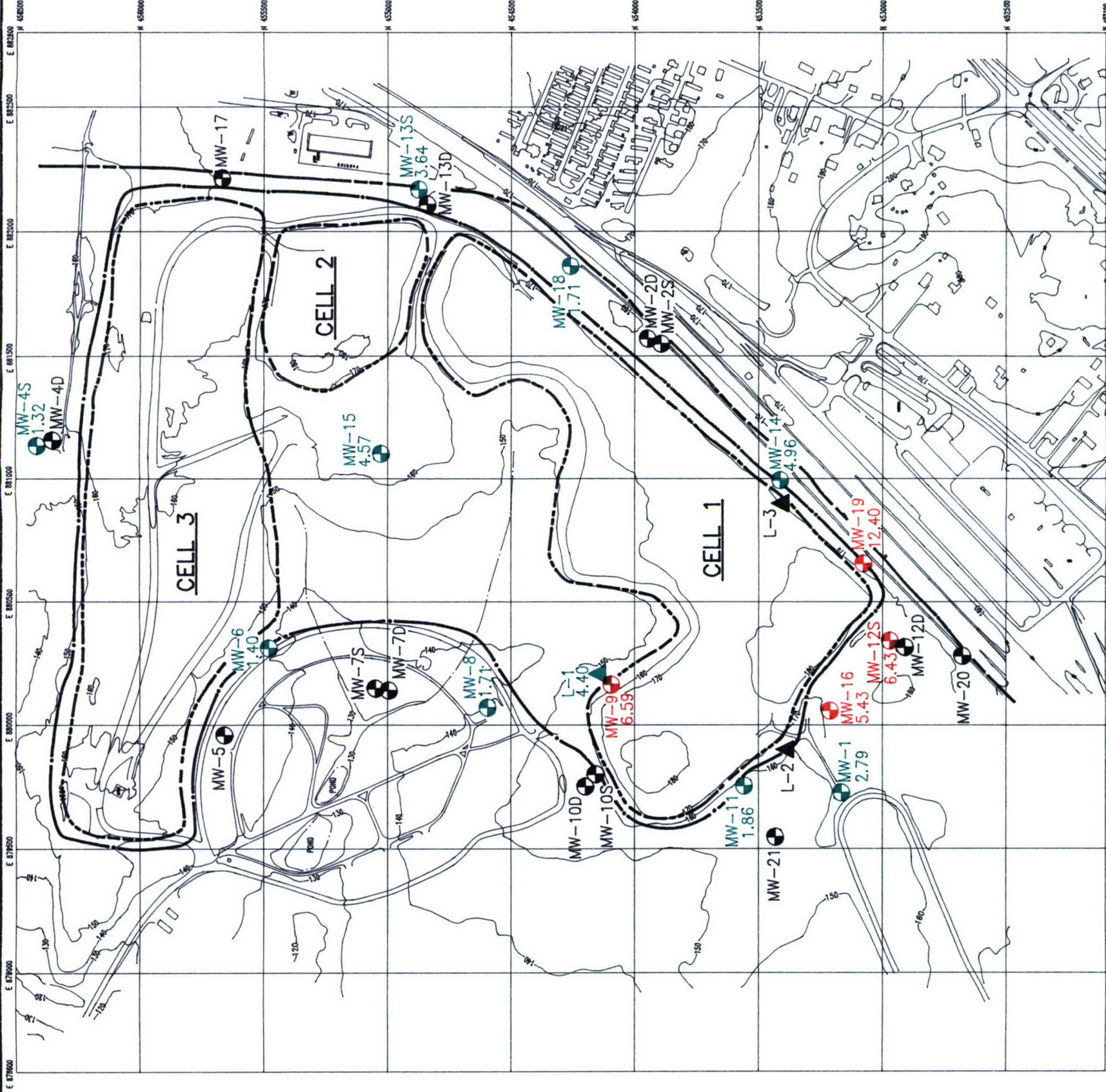
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SCIENCE, AND  
TECHNOLOGY, INC.

FORT MEADE  
REMEDIATION INVESTIGATION  
FORT MEADE, MARYLAND

ACTIVE SANITARY LANDFILL  
DISTRIBUTION OF TOTAL VOLATILE  
ORGANIC COMPOUNDS REPORTED IN  
GROUND-WATER AND LEACHATE DATA

DESIGNED BY SAB	DRAWN BY PMS	DATE 10-9-91	PROJECT NO. 10559.05	FILE NAME ASL-TVOD
CHECKED BY KWK	PROJECT MGR. SAB	SCALE 1"=500'	DRAWING NO. -	FIGURE 2.3-1





**LEGEND**

- APPROXIMATE LIMIT OF PERMITTED LANDFILL AREA
- FORT MEADE RESERVATION BOUNDARY
- APPROXIMATE LANDFILL CELL BOUNDARY
- TOPOGRAPHIC CONTOUR IN FEET ABOVE MSL

MW-16  
5.43  
MONITORING WELL  
BENZENE LEVEL

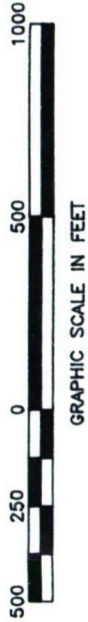
L-1  
4.40  
LEACHATE SAMPLE  
BENZENE LEVEL

**COLOR CODING SCHEME**

- BENZENE LEVEL ND (NOT DETECTED)
- BENZENE LEVEL >ND - MCL (5 ug/l)
- BENZENE LEVEL >MCL (5 ug/l)

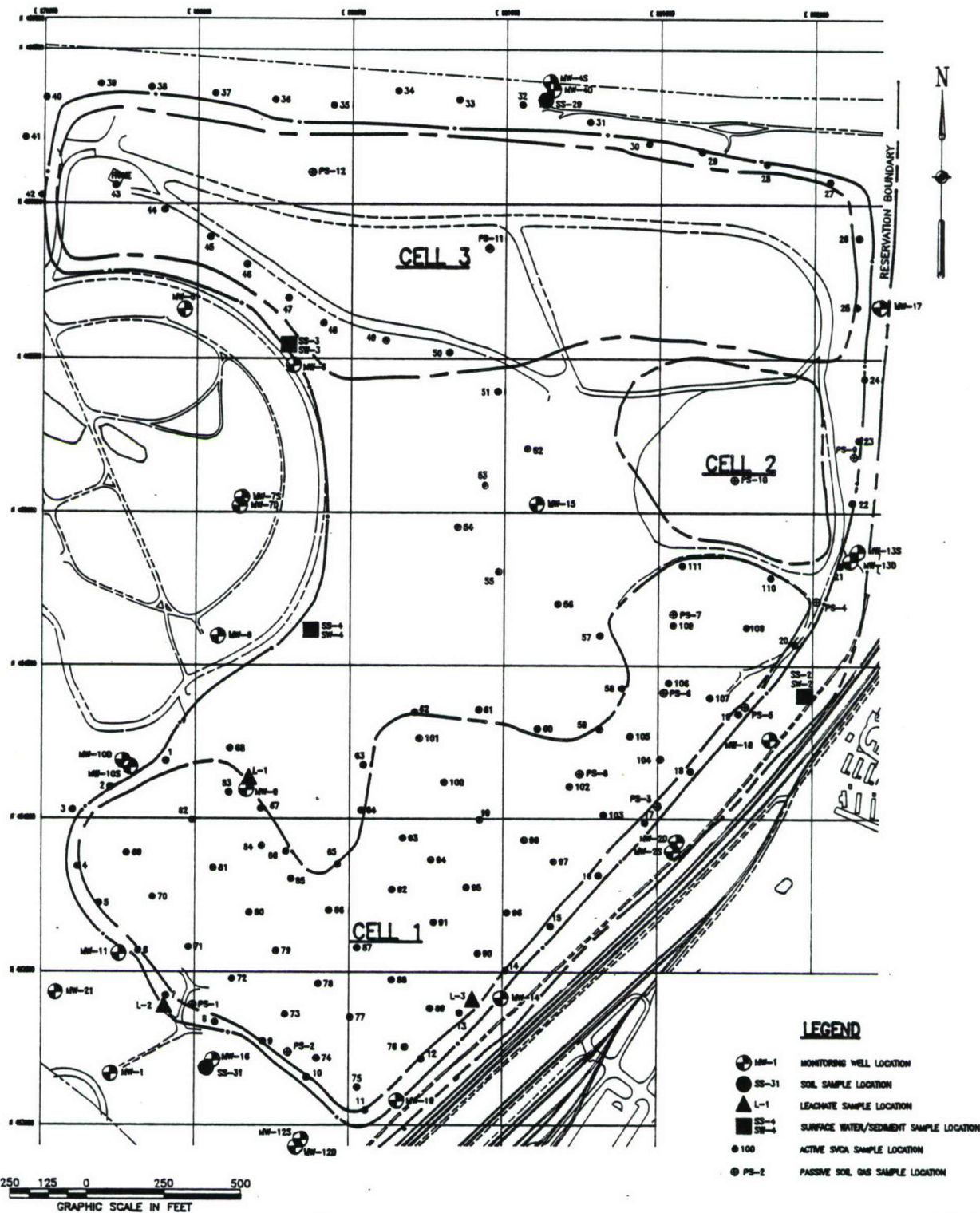
**NOTES**

- CELL 1 AND 2 BOUNDARY OUTLINES AREA WHERE 2-10 FT. LIFTS HAVE BEEN PLACED OVER TRENCH FILL AREA.
- CELL 3 BOUNDARY DEPICTS APPROXIMATE EXTENT OF TRENCH FILL AREA.
- DASHED GROUND-WATER CONTOUR LINES INFERRED FROM SURFACE TOPOGRAPHY.
- CHEMICAL DATA UNITS: ug/l.



EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	FORT MEADE REMEDIAL INVESTIGATION FORT MEADE, MARYLAND	ACTIVE SANITARY LANDFILL BENZENE LEVELS REPORTED IN GROUND-WATER AND LEACHATE DATA			DESIGNED BY SAB	DRAWN BY PMS	DATE 10-9-91	PROJECT NO. 10559.05	FILE NAME ASL-BLS
					CHECKED BY KWK	PROJECT MGR. SAB	SCALE 1"=500'	DRAWING NO. -	FIGURE 2.3-2





FILE: ASL-SG

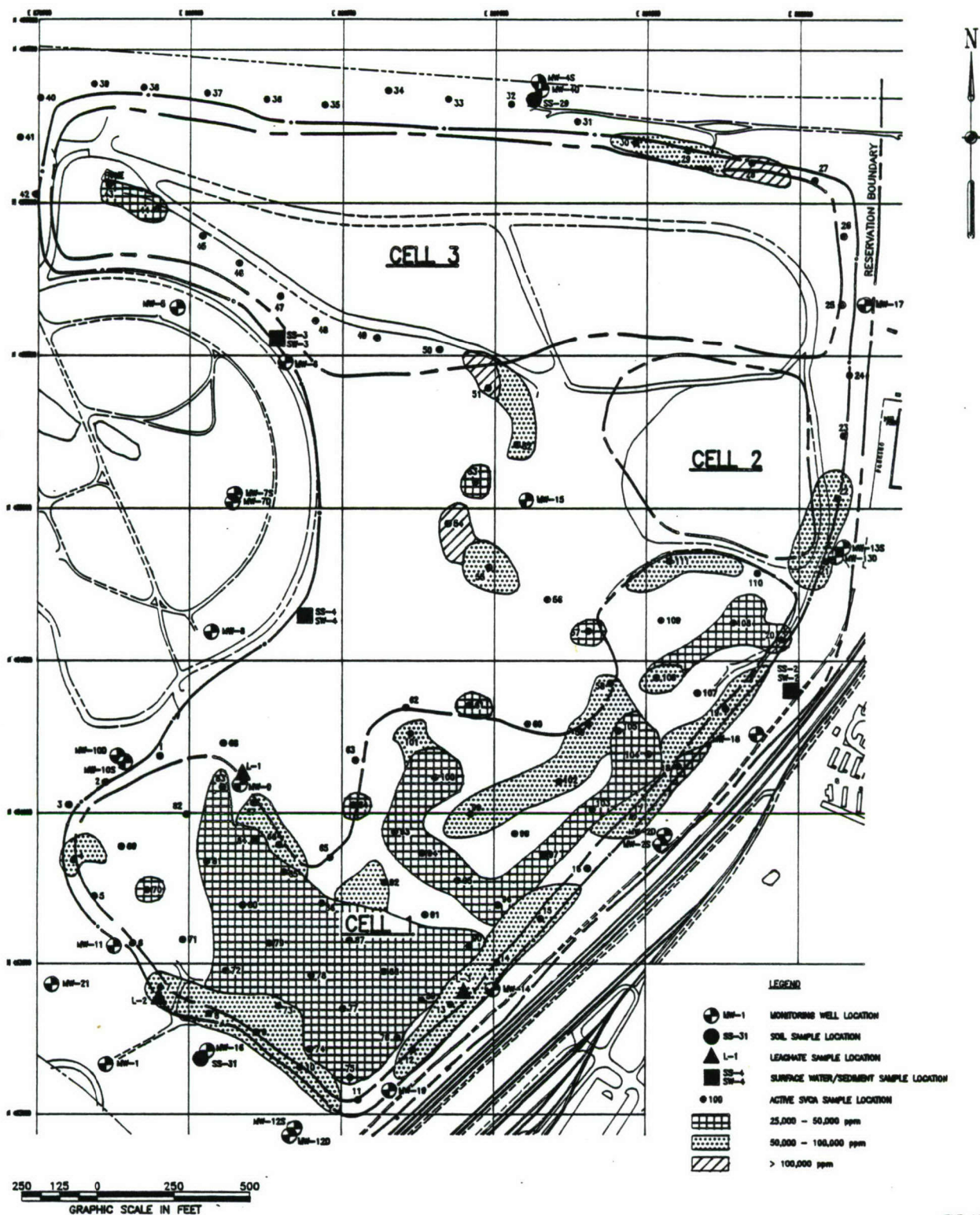
**EA** EA ENGINEERING,  
SCIENCE, AND  
TECHNOLOGY, INC.

FORT MEADE  
REMEDIAL INVESTIGATION  
FORT MEADE, MARYLAND

ACTIVE SANITARY LANDFILL  
SOIL GAS SAMPLE  
LOCATIONS

PROJECT MGR SAB	DESIGNED BY VAW	DRAWN BY PMS	CHECKED BY KWK	SCALE 1"=500'	DATE 10-11-91	PROJECT NO 10559.05	FIGURE 2.3-3
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**FORT MEADE  
REMEDIAL INVESTIGATION  
FORT MEADE, MARYLAND**

**ACTIVE SANITARY LANDFILL  
DISTRIBUTION OF METHANE  
SOIL GAS DATA**

PROJECT MGR  
SAB

DESIGNED BY  
VAW

DRAWN BY  
PMS

CHECKED BY  
KWK

SCALE  
1"=500'

DATE  
10-11-91

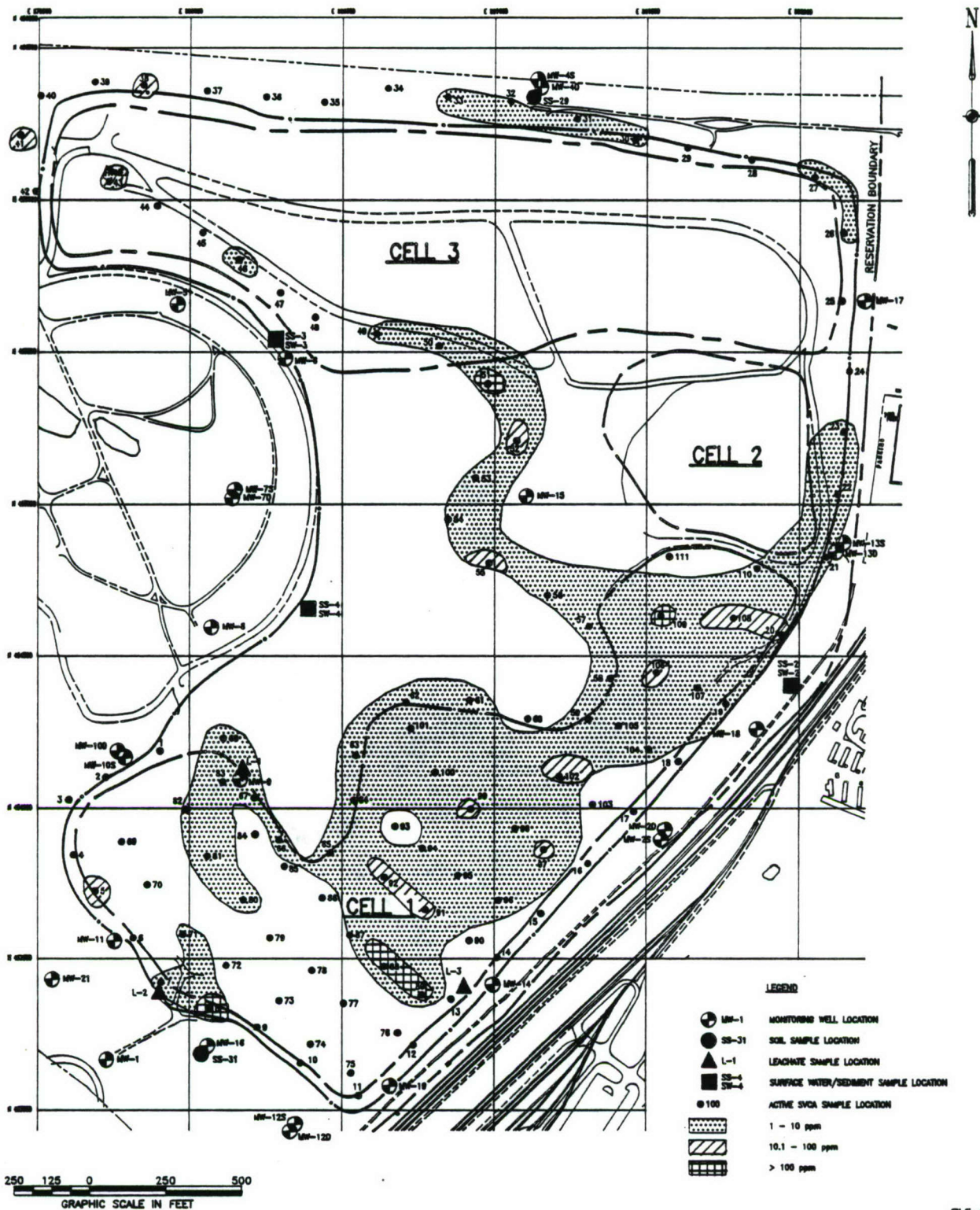
PROJECT NO  
10559.05

FIGURE  
2.3-4









FILE: ASL-MCD



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**FORT MEADE  
REMEDIAL INVESTIGATION  
FORT MEADE, MARYLAND**

**ACTIVE SANITARY LANDFILL  
DISTRIBUTION OF METHYLENE  
CHLORIDE SOIL GAS DATA**

PROJECT MGR  
SAB

DESIGNED BY  
VAW

DRAWN BY  
PMS

CHECKED BY  
KWK

SCALE  
1"=500'

DATE  
10-11-91

PROJECT NO  
10559.05

FIGURE  
2.3-6







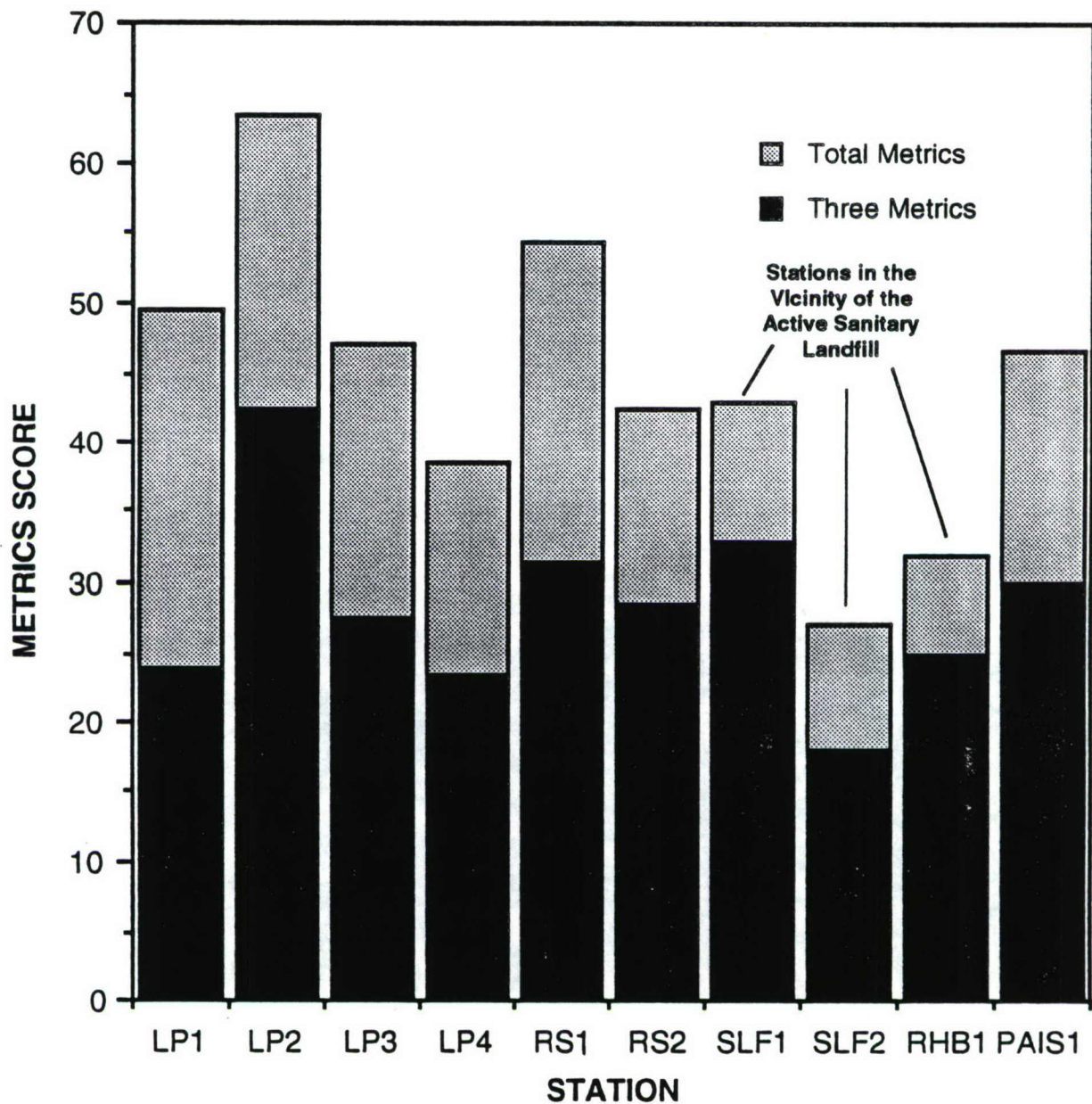


Figure 2.3-8. Metric scores based on rank for sampling stations in the vicinity of the Active Sanitary Landfill. (Individual metrics results are provided in Appendix A.9.)

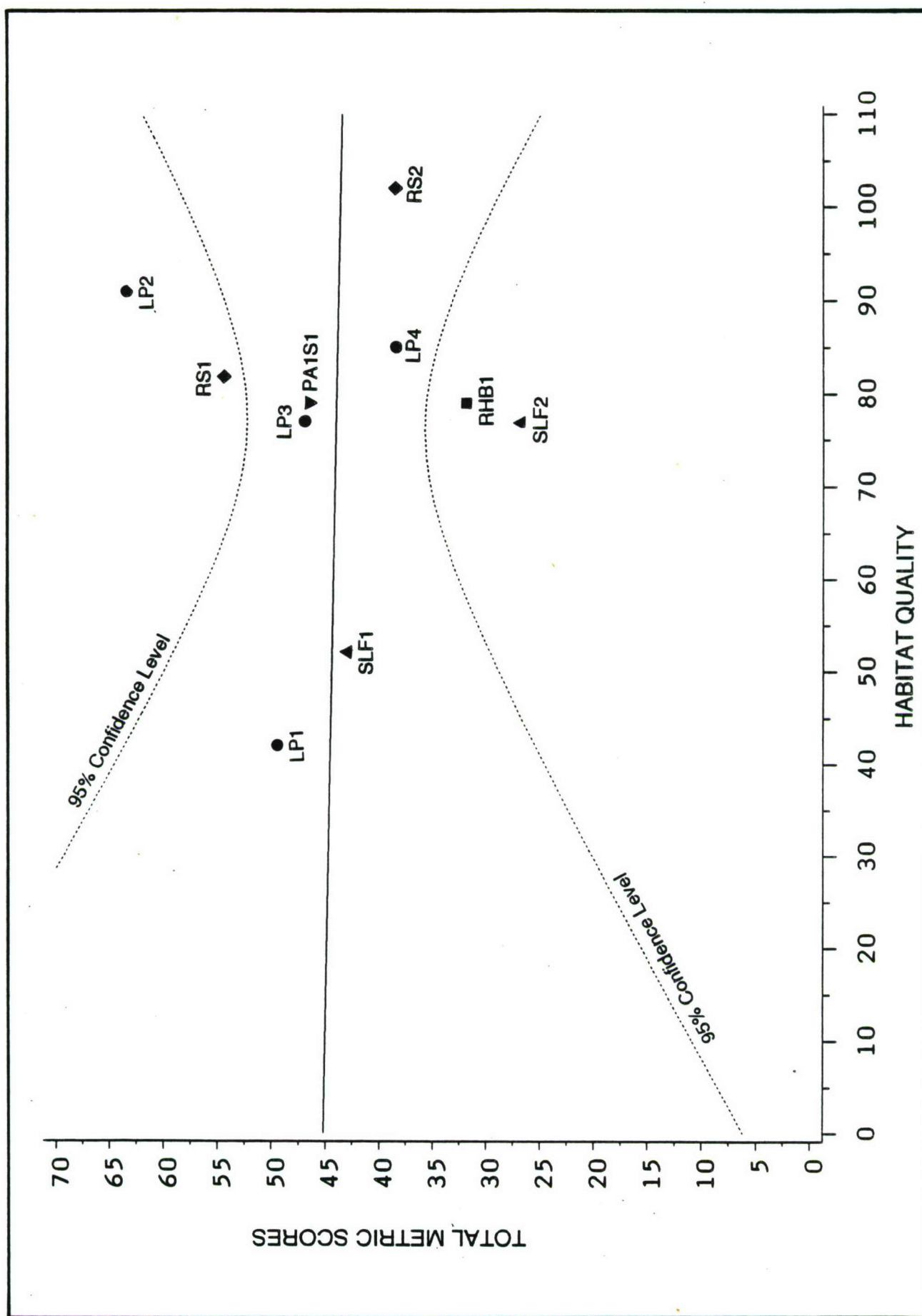


Figure 2.3-9. Benthic assessment stations at Fort Meade comparing the relationship of habitat quality to all metric scores.



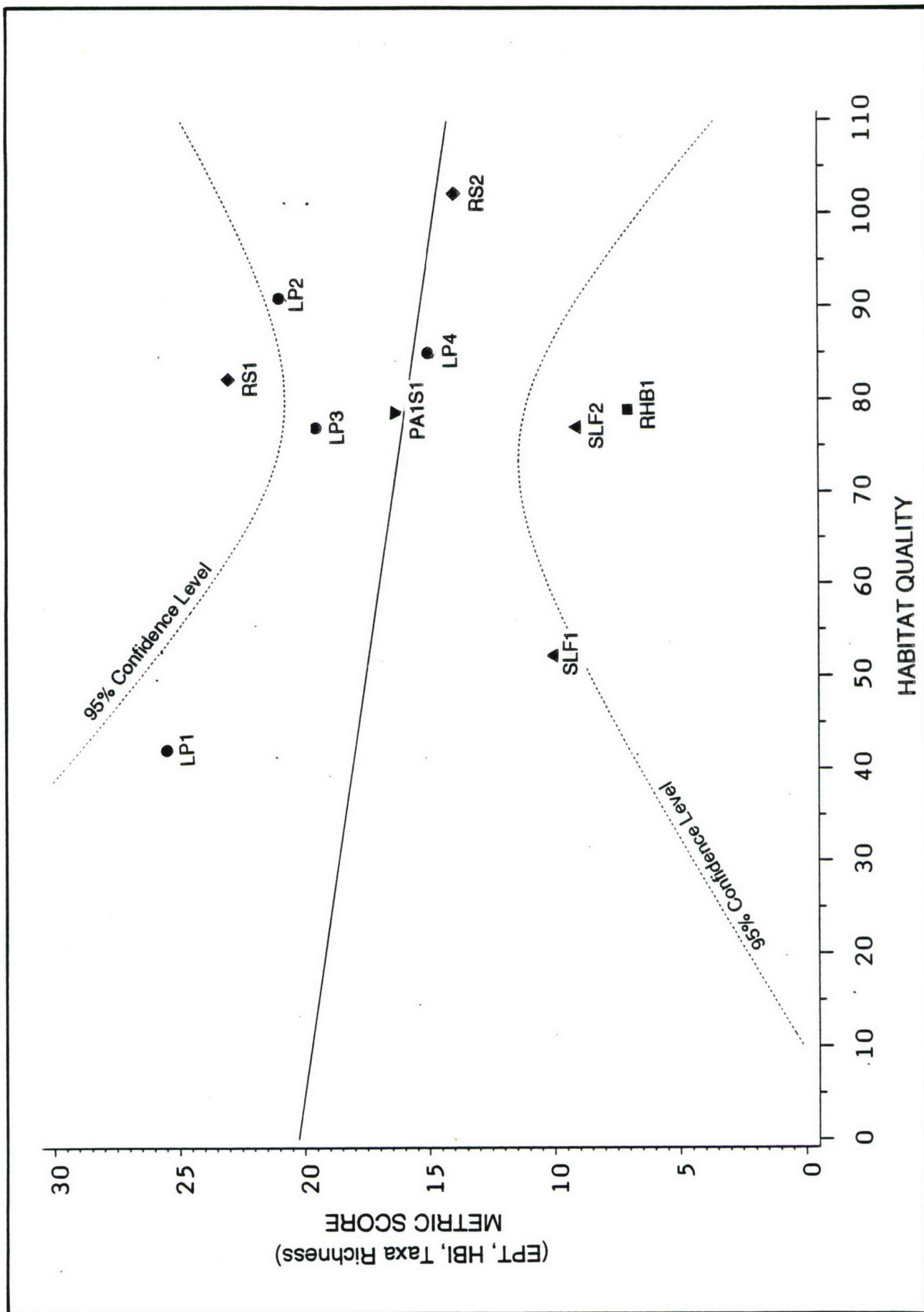


Figure 2.3-10. Benthic assessment of biological stations at Fort Meade comparing the relationship of habitat quality to the total score of the three metrics (EPT, HBI, Taxa Richness).

TABLE 2.3-1 SURFICIAL SOIL ORGANIC DATA

<u>Parameter</u>	<u>SS-29</u>	<u>Sample ID</u>	
		<u>SS-30</u>	<u>SS-31</u>
VOLATILES		ND	ND
2-Butanone	8.16		
SEMIVOLATILES	ND	ND	ND
PESTICIDES			ND
4,4'-DDD	0.004		
4,4'-DDE	0.008		
4,4'-DDT	0.010		
Aldrin	0.005	0.003	
Endosulfan I	0.011		
Lindane	0.001	0.003	

---

Units:  $\mu\text{g/g}$ .

ND: Not detected.



TABLE 2.3-2 SURFICIAL SOIL METALS AND NON-METALS DATA ( $\mu\text{g/g}$ )

<u>Parameter</u>	<u>SS-29</u>	<u>Sample ID</u> <u>SS-30</u>	<u>SS-31</u>
Aluminum	11,000	5,380	5,130
Antimony	<19.6	<19.6	<19.6
Arsenic	<2.5	<2.5	<2.5
Barium	24.0	21.9	20.5
Beryllium	<0.427	<0.427	<0.427
Cadmium	<1.2	<1.2	<1.2
Calcium	134.0	86.0	92.4
Chromium	7.71	6.84	5.4
Cobalt	<2.5	<2.5	<2.5
Copper	13.1	5.99	4.62
Iron	4,960	6,010	4,480
Lead	49	8.5	8.3
Magnesium	247	350	304
Manganese	2.22	170	22.4
Mercury	0.0655	<0.05	<0.05
Nickel	3.81	4.05	<2.74
Potassium	401	330	326
Selenium	<0.449	<0.449	<0.449
Silver	0.053	<0.0124	<0.0124
Sodium	<38.7	<38.7	<38.7
Thallium	<34.3	<34.3	<34.3
Vanadium	14.0	12.6	9.38
Zinc	36.1	15.8	9.47
Cyanide	<0.25	<0.25	<0.25

Units:  $\mu\text{g/g}$ .

TABLE 2.3-3 SURFACE WATER ORGANIC DATA

Parameter	Sample ID					
	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7
VOLATILES						
	ND	ND	ND	ND	ND	ND
SEMIVOLATILES						
	ND	ND	ND	ND	ND	ND
PESTICIDES						
4,4' -DDD		0.025				
4,4' -DDE	0.006	0.007				
4,4' -DDT	0.028			0.009		
Aldrin		0.036				
Alpha-BHC	0.005	0.005			0.004	0.004
Delta-BHC	0.005				0.013	
Endosulfan I		0.007	0.010	0.007		
Endosulfan II			0.006			
Heptachlor			0.029			
Isodrin			0.004			
Lindane			0.005	0.005		
Methoxychlor			0.007	0.008		0.004

Units:  $\mu\text{g/L}$ .

ND: Not detected.



TABLE 2.3-4 SURFACE WATER INORGANIC AND FIELD DATA

Parameter	Sample ID						
	SW-2	SW-3	SW-4	SW-5	SW-6	SW-7	
TOTAL METALS ( $\mu\text{g/L}$ )							
Aluminum	314.0	<112.0	331.0	343.0	232.0	184.0	
Antimony	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00	
Arsenic	3.04	<2.35	4.90	<2.35	<2.35	2.47	
Barium	10.80	215.0	53.20	60.80	29.10	57.00	
Beryllium	<1.12	<1.12	<1.12	<1.12	<1.12	<1.12	
Cadmium	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78	
Calcium	17,800	171,000	23,800	35,700	33,100	66,500	
Chromium	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80	
Cobalt	<25.00	<25.00	<25.00	<25.00	<25.00	<25.00	
Copper	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80	
Iron	747.0	34,000	25,200	1,850.0	1,980.0	3,020.0	
Lead	5.65	<4.47	<4.47	<4.47	<4.47	<4.47	
Magnesium	2,710.0	22,800	7,430.0	6,500.0	6,080.0	11,300	
Manganese	<9.67	565.0	224.0	176.0	79.90	313.0	
Mercury	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	
Nickel	<32.10	<32.10	<32.10	<32.10	<32.10	<32.10	
Potassium	<1,240.0	17,700	6,060.0	4,370.0	5,790.0	9,270.0	
Selenium	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53	
Silver	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	
Sodium	1,050.0	26,600	26,000	78,000	67,000	24,200	
Thallium	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0	
Vanadium	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60	
Zinc	<18.00	<18.00	<18.00	32.20	<18.00	<18.00	
OTHER INORGANIC ( $\mu\text{g/L}$ )							
Cyanide					6.48		
PHYSICAL PARAMETERS (mg/L)							
Total Suspended Solids	40	78	58	11	87		
Hardness (mg $\text{CaCO}_3/\text{L}$ )	55.6	521	90.0	116.0	107.7	356	

TABLE 2.3-5 SURFACE WATER QUALITY CRITERIA

<u>Parameter</u>	<u>A</u>	<u>B</u>	<u>C</u>
<b>METALS</b>			
Aluminum <sup>(b)</sup>	750	87	--
Antimony <sup>(b)</sup>	9,000	1,600	45,000 <sup>(b)</sup>
Arsenic <sup>(c)</sup>	360	190	0.0175 <sup>(b)</sup>
Beryllium <sup>(b)</sup>	130	5.3	0.117
Cadmium	3.9	1.1	--
Chromium, Total	--	--	--
Hexavalent	16	11	--
Trivalent	1,700	210	3,433,000
Copper	18	12	--
Cyanide	22	5.2	--
Iron	--	1,000 <sup>(b)</sup>	--
Lead	82	3.2	--
Mercury	2.4	0.012	0.146
Nickel	1,400	160	100
Selenium	20	5	--
Silver	4.1	0.12	--
Thallium <sup>(b)</sup>	1,400	40	48
Zinc	120	110	--
<b>PESTICIDES</b>			
Aldrin	3	--	0.00079
DDT	1.1	0.001	0.00024
Lindane	2	0.08	0.625
Alpha-BHC	--	--	0.0310
Delta-BHC	--	--	0.0547
Endosulfan	0.22	0.056	159
Heptachlor	0.52	0.0038	0.00029
Isophorone	117,000	--	520,000
Methoxychlor	0.03	--	--

(a) Criteria adopted in Maryland water quality standards (COMAR 28.08.02) except where noted.

A = Acute criteria for the protection of aquatic life; criteria represent 1-hour average concentrations that should not be exceeded more than once every 3 years.

B = Chronic criteria for the protection of aquatic life; criteria represent 4-day average concentrations that should not be exceeded more than once every 3 years.

C = Criteria for the protection of human health from carcinogenicity ( $10^{-6}$  risk level) or toxicity resulting from ingestion of aquatic organisms.

(b) U.S. EPA criterion; no Maryland criterion.

(c) Aquatic life criteria apply to trivalent arsenic; human health criterion and monitoring data are total arsenic.

Units:  $\mu\text{g/L}$ .



TABLE 2.3-6 STREAM SEDIMENT ORGANIC DATA

Parameter	Sample ID					
	SS-2	SS-3	SS-4	SS-5	SS-6	SS-7
VOLATILES	ND	ND	ND	ND	ND	ND
SEMIVOLATILES		ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	13.10					
Di-n-butyl phthalate	2.48					
Fluoranthene	0.17					
Phenanthrene	0.38					
Pyrene	0.29					
PESTICIDES						
4,4' -DDD	0.051	0.042	0.006	0.017	0.003	0.056
4,4' -DDE	0.039	0.008		0.004		0.011
4,4' -DDT	>0.100	0.042		0.018		0.030
Aldrin	0.005					
Aroclor-1260		0.31		0.061		0.21
Endosulfan I	0.021		0.003		0.004	
Endosulfan II				0.001	0.001	0.006
Endrin	0.021					
Heptachlor	0.008					0.007
Heptachlor epoxide	0.027		0.002			
Methoxychlor	0.14					
GENERAL ORGANIC						
Total organic carbon	56,100	164,000	14,300	12,300	10,800	149,000

Units:  $\mu\text{g/g}$ .

TABLE 2.3-7 STREAM SEDIMENT INORGANIC DATA

Parameter	Sample ID					
	SS-2	SS-3	SS-4	SS-5	SS-6	SS-7
Aluminum	15,200	17,700	2,490.0	1,920.0	1,960.0	27,800
Antimony	<19.60	<19.60	<19.60	<19.60	<19.60	<19.60
Arsenic	8.67	11.70	<2.50	<2.50	<2.50	9.50
Barium	65.10	235.0	9.35	11.60	9.45	154.0
Beryllium	<0.43	<0.43	<0.43	<0.43	<0.43	1.38
Cadmium	<1.20	<1.20	<1.20	<1.20	<1.20	<1.20
Calcium	4,120.0	12,000	551.0	1,460.0	7,200.0	6,460.0
Chromium	39.60	34.30	12.30	8.30	11.90	49.70
Cobalt	6.96	<2.50	<2.50	<2.50	<2.50	26.00
Copper	44.50	37.10	14.50	6.19	6.30	51.00
Iron	24,700	160,000	8,990.0	5,780.0	7,820.0	47,500
Lead	82.00	42.90	3.03	14.00	4.30	78.00
Magnesium	4,860.0	2,480.0	502.0	620.0	3,400.0	4,590.0
Manganese	92.00	238.0	18.40	32.70	49.20	1,470.0
Mercury	0.13	<0.050	0.099	<0.050	<0.050	0.16
Nickel	40.20	16.80	4.63	5.29	18.10	43.90
Potassium	1,500.0	2,160.0	394.0	211.0	387.0	2,900.0
Selenium	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45
Silver	1.10	2.70	0.057	<0.012	0.079	1.50
Sodium	93.00	241.0	<38.70	55.70	<38.70	437.0
Thallium	<34.30	<34.30	<34.30	<34.30	<34.30	<34.30
Vanadium	43.70	50.00	26.80	7.20	8.85	67.70
Zinc	136.0	151.0	19.70	25.20	17.90	237.0

Units:  $\mu\text{g/g}$ .



TABLE 2.3-8 UPPER PATAPSCO GROUND-WATER ORGANIC DATA

Parameter	MCL	MW-1	MW-2S	MW-4S	MW-5	MW-6	Sample ID MW-7S	MW-8	MW-9	MW-10S	MW-11	MW-12S
<b>VOLATILES</b>												
1,1-Dichloroethane	----											5.23
1,2-Dichloropropane	5.00											2.57
Benzene	5.00	2.79		1.32		1.40		1.71	6.59		1.86	6.43
Chlorobenzene	----					15.4						2.31
Chloroform	----	4.70										
1,1-Dichloroethane	----									5.45		
Ethylbenzene	700	3.10						1.00	28.0			9.00
Toluene	1,000	10.0		3.20				5.50	6.60			
Xylenes	10,000	6.24							32.7		4.95	2.28
<b>TENTATIVELY IDENTIFIED VOLATILES</b>												
1,3-Dimethylbenzene	----	4.64		1.11				1.61	37.3			7.20
Dichlorobenzene	----					3.46			13.1			
Methylisobutyl ketone	----								23.1			
Trichlorofluoromethane	----									2.69		
<b>SEMIVOLATILES</b>												
1,4-Dichlorobenzene	75.0								17.8			10.6
2,4-Dimethylphenol	----								8.20			
Bis(2-ethylhexyl)phthalate	----											
Diethyl phthalate	----								105.		25.7	14.3
Naphthalene	----								13.0		4.24	3.53
p-Chloro-m-cresol	----								13.6			
<b>TENTATIVELY IDENTIFIED SEMIVOLATILES</b>												
Bromacil	----				7.30							
<b>PESTICIDES</b>												
4,4'-DDD	----	.006									.150	.051
4,4'-DDE	----											
4,4'-DDT	----					.082			.140		.100	
Alpha-BHC	----					.009					.035	.005
Beta-BHC	----					.020						.013
Delta-BHC	----					.077			.098			.006
Dieldrin	----											
Endosulfan I	----		.010					.014		0.011	.045	.029
Endosulfan II	----										.083	
Endrin	0.20								.092		.043	
Heptachlor	0.40					.027			.086		.110	
Heptachlor epoxide	0.20					.034			.093			.015
Isodrin	----					.023			.120		.091	
Lindane	0.20	.008				.016		.010	.088		.082	.013
Methoxychlor	40.0						.006		.066		.037	.017

Units: µg/L.

No MCL exists for compound.

These values are displayed in a format for improved readability. For information on the number of significant figures, consult the USATHAMA QA Program Manual.

TABLE 2.3-8 EXTENDED

Parameter	MCL	MW-13S	MW-14	MW-15	MW-16	MW-17	Sample ID MW-18	MW-19	MW-20	MW-21	Field Blank	Trip Blank
<b>VOLATILES</b>												
1,1-Dichloroethane	---	5.88										ND
1,2-Dichloroethane (total)	---	13.2										
1,2-Dichloropropane	---											
Benzene	5.00	3.64	4.96	4.57	5.43		1.71	12.4			1.93	
Carbon Tetrachloride	---										1.63	
Chlorobenzene	---		23.1								1.01	
Chloroform	---										1.54	
Ethylbenzene	700		13.0	75.0	3.30			24.0			1.80	
Tetrachloroethene	---	1.48									1.80	
Toluene	1,000		7.40	7.60				2.20		1.00	1.02	
Trichloroethene	5.00	2.40									2.10	
Xylenes	10,000		4.75	88.1		2.18		9.31		1.92	3.66	
<b>TENTATIVELY IDENTIFIED VOLATILES</b>												
1,3-Dimethylbenzene	---		5.05	121.				5.55				
Dichlorobenzene	---	2.43	7.01			6.54						
Trichlorofluoromethane	---											
<b>SEMIVOLATILES</b>												
1,2-Dichlorobenzene	600											
1,4-Dichlorobenzene	75.0		7.16			7.52		9.48				
Diethyl phthalate	---	20.0						7.89				
Naphthalene	---		11.9	24.0	3.95	16.9		63.8				
p-Chloro-m-cresol	---			19.1				22.6				
<b>TENTATIVELY IDENTIFIED SEMIVOLATILES</b>												
Atrazine	3.00						21.7					
<b>PESTICIDES</b>												
4,4'-DDD	---	.012										
4,4'-DDE	---	.011										
4,4'-DDT	---	.021										
Aldrin	---		.030	.041	.023							
Alpha-BHC	---	.011		.038	.004							
Dieldrin	---	.010										
Endosulfan I	---	.039	.039	.063	.013	0.10	.007	.140				
Endosulfan II	---	.020		.013				.091				
Endrin	0.20	.021										
Heptachlor	0.40		.030	.037		.063		.100				
Heptachlor epoxide	0.20	.023	.015	.071	.012			.130				
Isodrin	---	.010			.005							
Lindane	0.20	.027	.021	.031	.008	0.20	.005	.059				
Methoxychlor	40.0			.180		0.27						



TABLE 2.3-9 FREQUENCY OF DETECTION OF VOLATILE ORGANIC COMPOUNDS

Parameter	Well No.																					Total
	1	2S	4S	5	6	7S	8	9	10S	11	12S	13S	14	15	16	17	18	19	20	21		
Benzene	X		X	X		X	X	X		X	X	X	X	X	X		X	X		13		
Chloroform	X																			1		
Ethylbenzene	X						X	X			X		X	X	X	X		X		8		
Toulene	X		X			X	X	X					X	X		X		X	X	8		
Xylenes (Total)	X						X	X		X	X		X	X		X	X	X		8		
1,3-Dimethylbenzene	X		X			X	X	X					X	X				X		7		
1,1-Dichloroethane									X		X									3		
Trichlorofluormethane									X			X								1		
Chlorobenzene					X						X		X							3		
1,2, Dichloropropane											X									1		
Dichlorobenzene				X				X			X		X			X				6		
Tetrachloroethene											X	X								1		
Trichloroethene												X								1		
1,2-Dichloroethene (total)												X								1		
Methylisobutyl Ketone	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-		
Total	6	0	3	0	3	0	4	7	2	2	7	6	6	5	2	3	1	5	0	1	62	

TABLE 2.3-10 UPPER PATAPSCO AQUIFER TOTAL METALS DATA

Parameter	MCL	SMCL	MW-1	MW-2S	MW-4S	Sample ID				
						MW-5	MW-6	MW-7S	MW-8	
Aluminum	----	50-200	12,300	132.0	5,340.0	5,160.0	247.0	333.0	430.0	
Antimony	----	----	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00	
Arsenic	50.0	----	2.99	5.17	<2.35	<2.35	<2.35	5.63	<2.35	
Barium	2,000	----	144.0	44.00	88.10	95.70	185.0	25.30	19.30	
Beryllium	----	----	1.86	<1.12	<1.12	2.12	<1.12	<1.12	<1.12	
Cadmium	5.00	----	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78	
Calcium	----	----	1,410.0	9,460.0	5,910.0	4,410.0	70,000	9,270.0	1,870.0	
Chromium	100	----	23.80	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80	
Cobalt	----	----	<25.00	<25.00	<25.00	<25.00	39.40	<25.00	<25.00	
Copper	1,300(a)	1,000	21.30	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80	
Iron	----	300	11,500	143,000	16,300	5,560.0	118,000	34,400	2,190.0	
Lead	15.0(a)	----	6.62	<4.47	10.90	11.40	<4.47	<4.47	6.62	
Magnesium	----	----	1,370.0	1,580.0	1,700.0	2,250.0	31,500	2,190.0	759.0	
Manganese	----	50	210.0	1,030.0	106.0	240.0	1,110.0	375.0	109.0	
Mercury	2.00	----	<0.100	<0.100	0.16	<0.100	<0.100	<0.100	<0.100	
Nickel	----	----	<32.10	<32.10	<32.10	<32.10	<32.10	<32.10	<32.10	
Potassium	----	----	2,320.0	3,110.0	2,040.0	<1,240.0	28,300	<1,240.0	<1,240.0	
Selenium	50.0	----	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53	
Silver	50.0	100	<0.33	1.04	<0.33	<0.33	0.48	<0.33	<0.33	
Sodium	----	----	1,510.0	6,500.0	4,620.0	17,300	81,000	9,980.0	3,570.0	
Thallium	----	----	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0	
Vanadium	----	----	48.80	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60	
Zinc	----	5,000	80.20	<18.00	92.60	38.10	19.80	<18.00	<18.00	

(a) Action Level.

Units: µg/L.

----- No MCL or SMCL exist for this parameter.

MCL Maximum Contaminant Level.

SMCL Secondary Maximum Contaminant Level.



TABLE 2.3-10 EXTENDED

Parameter	MCL	SMCL	MW-9	MW-10S	MW-11	Sample ID MW-12S	MW-13S	MW-14	MW-15
Aluminum	----	50-200	8,150.0	548.0	426.0	<112.0	768.0	5,450.0	20,700
Antimony	----	----	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00
Arsenic	50.0	----	18.00	<2.35	26.70	38.50	<2.35	2.70	3.60
Barium	2,000	----	221.0	30.20	336.0	77.80	128.0	114.0	279.0
Beryllium	----	----	<1.12	<1.12	<1.12	1.55	<1.12	<1.12	<1.12
Cadmium	5.00	----	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78
Calcium	----	----	137,000	2,860.0	79,300	61,300	27,800	64,900	84,300
Chromium	100	----	28.50	<16.80	<16.80	<16.80	<16.80	<16.80	33.40
Cobalt	----	----	<25.00	<25.00	<25.00	<25.00	<25.00	<25.00	<25.00
Copper	1,300(a)	1,000	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80
Iron	----	300	92,800	5,730.0	80,300	103,000	38,700	167,000	195,000
Lead	15.0(a)	----	7.05	<4.47	<4.47	<4.47	<4.47	11.90	18.30
Magnesium	----	----	57,900	982.0	20,300	11,800	16,800	33,300	18,600
Manganese	----	50	292.0	112.0	150.0	407.0	454.0	954.0	305.0
Mercury	2.00	----	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Nickel	----	----	<32.10	<32.10	<32.10	<32.10	<32.10	<32.10	<32.10
Potassium	----	----	97,000	<1,240.0	35,900	5,970.0	5,830.0	21,000	18,600
Selenium	50.0	----	<2.53	<2.53	<2.53	<2.53	<2.53	3.44	<2.53
Silver	50.0	100	1.28	<0.33	0.45	<0.33	0.45	<0.33	<0.33
Sodium	----	----	230,000	2,600.0	58,000	11,300	67,000	100,000	14,400
Thallium	----	----	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0
Vanadium	----	----	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60	50.40
Zinc	----	5,000	22.90	31.00	<18.00	<18.00	86.00	27.10	53.90

TABLE 2.3-10 EXTENDED

Parameter	MCL	SMCL	Sample ID					
			MW-16	MW-17	MW-18	MW-19	MW-20	MW-21
Aluminum	----	50-200	1,800.0	4,150.0	1,970.0	1,280.0	1,400.0	662.0
Antimony	----	----	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00
Arsenic	50.0	----	2.81	3.60	2.70	16.80	3.15	<2.35
Barium	2,000	----	131.0	195.0	72.90	434.0	70.40	155.0
Beryllium	----	----	<1.12	<1.12	<1.12	<1.12	<1.12	1.87
Cadmium	5.00	----	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78
Calcium	----	----	12,800	35,100	20,000	128,000	5,770.0	5,580.0
Chromium	100	----	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80
Cobalt	----	----	<25.00	<25.00	<25.00	<25.00	<25.00	34.10
Copper	1,300(a)	1,000	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80
Iron	----	300	64,200	73,400	124,000	74,000	3,690.0	216.0
Lead	15.0(a)	----	<4.47	<4.47	<4.47	<4.47	10.70	<4.47
Magnesium	----	----	6,370.0	30,500	3,690.0	79,100	3,440.0	2,580.0
Manganese	----	50	1,230.0	119.0	748.0	443.0	190.0	136.0
Mercury	2.00	----	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Nickel	----	----	<32.10	<32.10	<32.10	<32.10	<32.10	57.00
Potassium	----	----	1,760.0	20,300	3,640.0	53,200	3,590.0	<1,240.0
Selenium	50.0	----	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53
Silver	50.0	100	<0.33	1.04	1.06	<0.33	0.68	<0.33
Sodium	----	----	34,700	44,700	15,700	330,000	10,300	13,900
Thallium	----	----	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0
Vanadium	----	----	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60
Zinc	----	5,000	49.30	<18.00	<18.00	<18.00	37.30	99.80



TABLE 2.3-11 UPPER PATAPSCO AQUIFER DISSOLVED METALS DATA

Parameter	MCL	SMCL	MW-1	MW-2S	MW-4S	Sample ID MW-5	MW-6	MW-7S	MW-8
Aluminum	----	50-200	2,090.0	<112.0	1,110.0	354.0	<112.0	<112.0	<112.0
Antimony	----	----	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00
Arsenic	50.0	----	<2.35	<2.35	<2.35	<2.35	<2.35	3.60	<2.35
Barium	2,000	----	102.0	44.00	69.20	<2.82	176.0	<2.82	<2.82
Beryllium	----	----	1.86	<1.12	<1.12	<1.12	<1.12	<1.12	<1.12
Cadmium	5.00	----	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78
Calcium	----	----	1,360.0	9,740.0	6,020.0	1,600.0	68,600	8,900.0	1,740.0
Chromium	100	----	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80
Cobalt	----	----	<25.00	<25.00	<25.00	<25.00	36.20	<25.00	<25.00
Copper	1,300(a)	1,000	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80
Iron	----	300	83.60	146,000	<77.50	405.0	118,000	31,200	841.0
Lead	15.0(a)	----	<4.47	<4.47	<4.47	<4.47	<4.47	<4.47	<4.47
Magnesium	----	----	1,080.0	1,570.0	1,580.0	722.0	30,900	2,190.0	699.0
Manganese	----	50	225.0	1,070.0	99.20	89.80	1090.0	380.0	92.80
Mercury	2.00	----	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Nickel	----	----	<32.10	<32.10	<32.10	<32.10	<32.10	<32.10	<32.10
Potassium	----	----	<1,240.0	3,600.0	1,880.0	<1,240.0	28,000	1,720.0	<1,240.0
Selenium	50.0	----	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53
Silver	50.0	100	<0.33	<0.33	<0.33	<0.33	0.59	<0.33	<0.33
Sodium	----	----	1,610.0	6,860.0	4,620.0	14,300	78,000	10,200	4,040.0
Thallium	----	----	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0
Vanadium	----	----	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60
Zinc	----	5,000	72.70	<18.00	73.30	<18.00	<18.00	<18.00	<18.00

(a) Action Level.

Units: µg/L.

----- No MCL or SMCL exist for this parameter.

MCL Maximum Contaminant Level.

SMCL Secondary Maximum Contaminant Level.

TABLE 2.3-11 EXTENDED

Parameter	MCL	SMCL	Sample ID					
			MW-9	MW-10S	MW-11	MW-12S	MW-13S	MW-14
Aluminum	----	50-200	145.0	<112.0	<112.0	<112.0	<112.0	<112.0
Antimony	----	----	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00
Arsenic	50.0	----	11.00	<2.35	8.29	39.70	<2.35	29.70
Barium	2,000	----	174.0	11.30	218.0	74.70	125.0	84.80
Beryllium	----	----	<1.12	<1.12	<1.12	<1.12	<1.12	<1.12
Cadmium	5.00	----	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78
Calcium	----	----	132,000	3,090.0	72,700	65,100	27,900	59,500
Chromium	100	----	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80
Cobalt	----	----	<25.00	<25.00	<25.00	<25.00	26.80	<25.00
Copper	1,300(a)	1,000	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80
Iron	----	300	71,400	2,690.0	64,200	93,300	36,300	144,000
Lead	15.0(a)	----	<4.47	<4.47	<4.47	<4.47	<4.47	<4.47
Magnesium	----	----	56,200	984.0	18,500	12,800	16,800	29,800
Manganese	----	50	234.0	98.70	160.0	364.0	471.0	928.0
Mercury	2.00	----	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Nickel	----	----	<32.10	<32.10	<32.10	<32.10	<32.10	<32.10
Potassium	----	----	93,200	<1,240.0	32,400	5,930.0	5,990.0	19,500
Selenium	50.0	----	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53
Silver	50.0	100	1.25	<0.33	0.45	0.36	0.39	<0.33
Sodium	----	----	230,000	2,600.0	51,700	16,500	66,000	97,000
Thallium	----	----	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0
Vanadium	----	----	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60
Zinc	----	5,000	<18.00	40.50	<18.00	<18.00	105.0	<18.00



TABLE 2.3-11 EXTENDED

Parameter	MCL	SMCL	Sample ID							
			MW-15	MW-16	MW-17	MW-18	MW-19	MW-20	MW-21	
Aluminum	----	50-200	<112.0	184.0	<112.0	<112.0	<112.0	<112.0	<112.0	402.0
Antimony	----	----	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00
Arsenic	50.0	----	5.85	<2.35	<2.35	<2.35	9.23	<2.35	<2.35	<2.35
Barium	2,000	----	178.0	111.0	169.0	64.10	370.0	82.30	143.0	143.0
Beryllium	----	----	<1.12	<1.12	<1.12	<1.12	<1.12	<1.12	<1.12	2.17
Cadmium	5.00	----	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78
Calcium	----	----	75,400	11,900	35,400	20,800	123,000	7,060.0	11,100	11,100
Chromium	100	----	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80
Cobalt	----	----	<25.00	<25.00	<25.00	<25.00	<25.00	<25.00	<25.00	30.70
Copper	1,300 <sup>(a)</sup>	1,000	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80
Iron	----	300	144,000	55,500	58,200	124,000	53,100	1,680.0	106.0	106.0
Lead	15.0 <sup>(a)</sup>	----	<4.47	<4.47	<4.47	<4.47	<4.47	<4.47	<4.47	<4.47
Magnesium	----	----	15,500	6,030.0	30,500	3,680.0	75,500	4,080.0	2,250.0	2,250.0
Manganese	----	50	215.0	1,160.0	117.0	773.0	421.0	193.0	112.0	112.0
Mercury	2.00	----	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Nickel	----	----	<32.10	<32.10	<32.10	<32.10	<32.10	<32.10	<32.10	57.50
Potassium	----	----	16,200	1,920.0	19,900	3,330.0	50,900	1,690.0	3,190.0	3,190.0
Selenium	50.0	----	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53
Silver	50.0	100	<0.33	<0.33	<0.33	<0.33	0.48	<0.33	<0.33	<0.33
Sodium	----	----	13,600	15,800	45,600	16,600	310,000	12,800	14,500	14,500
Thallium	----	----	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0
Vanadium	----	----	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60
Zinc	----	5,000	23.20	41.40	<18.00	<18.00	<18.00	27.70	55.70	55.70

TABLE 2.3-12 LOWER PATAPSCO AQUIFER ORGANIC DATA

<u>Parameters</u>	<u>MCL</u>	<u>MW-2D</u>	<u>MW-4D</u>	<u>MW-7D</u>	<u>Sample ID</u>	
					<u>MW-10D</u>	<u>MW-12D</u>
<u>VOLATILES</u>						
Toluene	1,000	ND	ND	ND	ND	ND
						1.60
<u>TENTATIVELY IDENTIFIED VOLATILES</u>						
1,3-Dimethylbenzene	-----	ND	ND	ND	ND	ND
						1.11
<u>SEMIVOLATILES</u>						
Bis(2-ethylhexyl)phthalate	-----	ND	ND	76.20	ND	ND
<u>PESTICIDES</u>						
4,4'-DDE	-----					0.009
4,4'-DDT	-----		0.013	0.065	0.009	3.59
Aldrin	-----					0.56
Alpha-BHC	-----			0.005		0.12
Beta-BHC	-----					0.20
Delta-BHC	-----					
Dieldrin	-----	0.062	0.17			0.006
Heptachlor	0.40	0.016	0.068		0.025	0.43
Isodrin	-----		0.007			0.090

Units:  $\mu\text{g/L}$ .

----- No MCL exists for this compound.



TABLE 2.3-13 LOWER PATAPSCO AQUIFER TOTAL METALS DATA

Parameter	MCL	SMCL	MW-2D	MW-4D	MW-7D	Sample ID MW-10D	MW-12D	MW-13D	USGSCC40
Aluminum	----	50-200	2,200.0	1,490.0	575.0	3,970.0	515.0	1,370.0	279.0
Antimony	----	----	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00
Arsenic	50.0	----	<2.35	<2.35	<2.35	<2.35	<2.35	<2.35	<2.35
Barium	2,000	----	20.10	148.0	126.0	129.0	254.0	23.50	12.00
Beryllium	----	----	<1.12	<1.12	2.42	1.62	<1.12	<1.12	<1.12
Cadmium	5.00	----	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78
Calcium	----	----	2,370.0	63,900	40,700	27,700	117,000	6,580.0	3,350.0
Chromium	100	----	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80
Cobalt	----	----	<25.00	<25.00	<25.00	36.60	<25.00	<25.00	<25.00
Copper	1,300 <sup>(a)</sup>	1,000	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80	97.30
Iron	----	300	4,400.0	490.0	170.0	5,100.0	2,050.0	1,720.0	33,700
Lead	15.0 <sup>(a)</sup>	----	<4.47	8.34	<4.47	<4.47	<4.47	<4.47	47.60
Magnesium	----	----	404.0	218.0	868.0	3,510.0	230.0	601.0	720.0
Manganese	----	50	<9.67	20.20	44.50	353.0	16.80	20.40	895.0
Mercury	2.00	----	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Nickel	----	----	<32.10	<32.10	<32.10	37.30	<32.10	<32.10	<32.10
Potassium	----	----	2,470.0	201,000	58,800	8,710.0	54,700	1,800.0	<1,240.0
Selenium	50.0	----	<2.53	4.03	<2.53	3.15	<2.53	<2.53	<2.53
Silver	50.0	100	<0.33	0.51	0.39	0.44	0.45	<0.33	<0.33
Sodium	----	----	2,000.0	88,000	45,500	12,600	56,000	2,420.0	2,200.0
Thallium	----	----	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0
Vanadium	----	----	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60
Zinc	----	5,000	19.00	43.90	51.10	66.70	38.40	66.90	116.0

(a) Action Level.

Units: µg/L.

----- No MCL or SMCL exist for this parameter.

MCL Maximum Contaminant Level.

SMCL Secondary Maximum Contaminant Level.

TABLE 2.3-14 LOWER PATAPSCO AQUIFER DISSOLVED METALS DATA

Parameter	MCL	SMCL	MW-2D	MW-4D	MW-7D	Sample ID MW-10D	MW-12D	MW-13D	USGSCC40
Aluminum	----	50-200	<112.0	334.0	299.0	<112.0	144.0	<112.0	270.0
Antimony	----	----	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00
Arsenic	50.0	----	<2.35	<2.35	<2.35	<2.35	<2.35	<2.35	<2.35
Barium	2,000	----	3.77	108.0	104.0	60.30	228.0	13.20	68.40
Beryllium	----	----	<1.12	<1.12	<1.12	<1.12	<1.12	<1.12	<1.12
Cadmium	5.00	----	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78
Calcium	----	----	1,740.0	37,800	28,500	13,400	104,000	5,800.0	115,000
Chromium	100	----	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80
Cobalt	---	----	<25.00	<25.00	<25.00	<25.00	<25.00	<25.00	<25.00
Copper	1,300 <sup>(a)</sup>	1,000	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80
Iron	----	300	<77.50	<77.50	<77.50	2,760.0	<77.50	<77.50	2,350.0
Lead	15.0 <sup>(a)</sup>	----	<4.47	<4.47	<4.47	<4.47	<4.47	<4.47	<4.47
Magnesium	----	----	248.0	<135.0	<135.0	2,800.0	<135.0	500.0	18,400
Manganese	----	50	<9.67	<9.67	<9.67	260.0	<9.67	18.60	137.0
Mercury	2.00	----	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Nickel	----	----	<32.10	<32.10	<32.10	<32.10	<32.10	<32.10	<32.10
Potassium	----	----	2,420.0	188,000	58,400	5,230.0	53,000	1,680.0	6,860.0
Selenium	50.0	----	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53
Silver	50.0	100	<0.33	0.42	0.36	<0.33	0.42	<0.33	<0.33
Sodium	----	----	1,860.0	80,000	46,400	10,300	52,400	2,360.0	14,800
Thallium	----	----	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0
Vanadium	----	----	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60
Zinc	----	5,000	<18.00	<18.00	76.20	38.70	<18.00	37.60	<18.00

(a) Action Level.

Units: µg/L.

----- No MCL or SMCL exist for this parameter.

MCL Maximum Contaminant Level.

SMCL Secondary Maximum Contaminant Level.



TABLE 2.3-15 LEACHATE ORGANIC DATA

<u>Sample ID</u>	<u>L-1</u>	<u>L-2</u>	<u>L-3</u>
VOLATILES			
Benzene	4.40		
Chlorobenzene		6.80	
Ethylbenzene	4.20	7.20	1.90
Toluene		5.90	
Xylenes	39.00		
SEMIVOLATILES			
1,3-Dichlorobenzene	13.70		
2,4-Dimethylphenol	4.84		
2-Methylnaphthalene		5.84	
4-Methylphenol			10.40
Diethyl phthalate	21.90		
Naphthalene	6.78		
p-Chloro-m-cresol	8.73		
PESTICIDES			
4,4'-DDE		0.012	
4,4'-DDT	0.018	0.034	
Alpha-BHC		0.011	0.010
Beta-BHC	0.026		
Delta-BHC	0.006	0.008	
Dieldrin		0.012	
Endosulfan I		0.040	0.016
Endosulfan II		0.011	0.022
Isodrin		0.004	
Lindane			0.026
Methoxychlor		0.34	

Units:  $\mu\text{g/L}$ .

TABLE 2.3-16 LEACHATE INORGANIC DATA

<u>Sample ID</u>	<u>L-1</u>	<u>L-2</u>	<u>L-3</u>
TOTAL METALS			
Aluminum	280,000	1,130.0	1,480.0
Antimony	<60.00	<60.00	<60.00
Arsenic	24.80	<2.35	<2.35
Barium	6,360.0	305.0	431.0
Beryllium	<1.12	<1.12	<1.12
Cadmium	<6.78	<6.78	<6.78
Calcium	1.0E+6	64,300	127,000
Chromium	720.0	<16.80	<16.80
Cobalt	220.0	<25.00	<25.00
Copper	730.0	<18.80	<18.80
Iron	2.0E+6	214,000	198,000
Lead	57.20	6.44	21.40
Magnesium	89,900	11,600	23,100
Manganese	4,700.0	962.0	948.0
Mercury	1.09	<0.100	<0.100
Nickel	400.0	44.10	<32.10
Potassium	125,000	8,840.0	27,000
Selenium	<2.53	<2.53	<2.53
Silver	<0.33	<0.33	2.03
Sodium	130,000	3,500.0	37,000
Thallium	2,900.0	178.0	292.0
Vanadium	1,300.0	<27.60	<27.60
Zinc	960.0	21.20	36.40
OTHER INORGANIC			
Cyanide	6.61	<5.0	12.7

Units:  $\mu\text{g/L}$ .



TABLE 2.3-17 HYDROCARBON AND METHANE RESULTS OF SOIL GAS SURVEY CONDUCTED AT THE FORT MEADE SANITARY LANDFILL

Sample	Depth (ft)	Pre-Benzene Peaks <sup>(c)</sup> (ppm)	Benzene (ppm)	Toluene (ppm)	Ethylbenzene (ppm)	Total Xylenes (ppm 0-xylene)	Methane (ppm)
VP-1	2		no sample obtained--water encountered				
VP-1	3		no sample obtained--water encountered				
VP-2	2	<0.1	<0.1	<0.1	<0.1	<0.1	<2
VP-2	3		no sample obtained--water encountered				
VP-3	3	<	<	<	<	<	<
VP-3	5	1.4	<	<	<	0.4	12
VP-3	8	<	<	<	<	0.2	6
VP-4	5	2.9	<	23	3.0	4.7	79,000
VP-4	8	1,000	<	21	2.0	3.3	68,000
VP-5	5	0.2	<	3.1	<	<	9,100
VP-6	5	<	<	<	<	<	5,600
VP-7	5	770	<	<	<	<	75,000
VP-8	5	1.0	<	<	<	<	79,000
VP-9	5	3.0	<	<	<	7.3	78,000
VP-10	5	2.9	<	<	<	18	92,000
VP-10	8	3.7	<	7.5	<	32	91,000
VP-11	5	2.8	<	10	7.5	<	36,000
VP-12	5	6.8	<	<	<	<	76,000
VP-13	5	<0.1	<	<	<	<	94,000
VP-14	5	14	<	3.0	3.4	3.8	72,000
VP-14D	5	5.3	<	7.2	7.3	31	(a)
VP-15	5	21	<	3.4	2.5	15	86,000
VP-15D	5		<	3.8	3.1	20	
VP-16	5	4.4	no data obtained--instrument error				
VP-17	5	11	<	<	<	2.7	18,000
			<	1.5	<	4.9	89,000

(a) No sample obtained.

(b) Unable to quantitate.

(c) Pre-benzene peaks are normalized to toluene.

< Indicates that when detected, the concentrations encountered were below the employed detection limits, i.e., 0.1 ppm aromatic hydrocarbons, 2 ppm methane.

TABLE 2.3-17 (Cont.)

Sample	Depth (ft)	Pre-Benzene Peaks <sup>(c)</sup> (ppm)	Benzene (ppm)	Toluene (ppm)	Ethylbenzene (ppm)	Total Xylenes (ppm O-xylene)	Methane (ppm)
VP-18	5	<	<	<	<	<	49,000
VP-18D	5	0.9	<	1.8	0.8	<	(a)
VP-19	5	0.6	<	<	<	2.7	93,000
VP-20	5	3.4	<	0.2	<	1.0	46,000
VP-21	5	11	<	<	<	2.4	61,000
VP-22	5	8.8	<	1.3	<	2.1	60,000
VP-23	5	3.3	<	<	<	1.2	1,200
VP-23D	5	10	<	1.8	<	2.6	(a)
VP-24	5	<	<	<	<	1.1	8,100
VP-25	5	0.9	<	1.3	<	2.2	1,200
VP-26	5	9.7	<	14	<	5.7	8,600
VP-27	5	<	<	<	<	<	960
VP-28	5	0.7	<	0.6	<	1.5	290,000
VP-29	5	0.6	<	<	<	1.6	68,000
VP-30	5	0.2	<	<	<	13	66,000
VP-31	5	<	<	<	<	<	<
VP-32	5	<	<	<	<	<	150
VP-33	5	<	<	<	<	<	7
VP-34	3	<	<	<	<	<	
VP-34	5	no sample obtained--water encountered					
VP-35	3	no sample obtained--water encountered					
VP-35	5	no sample obtained--high vacuums					
VP-35	5	no sample obtained--high vacuums					
VP-36	3	0.7	<	<	<	<	<
VP-37	3	4.7	<	0.6	<	<	<
VP-38	3	<	<	<	<	<	<
VP-38D	3	3.9	<	1.2	<	<	<
VP-39	3	2.9	<	0.6	<	<	<
VP-40	3	7.4	0.7	2.7	<	1.0	<
VP-41	5	no data obtained--instrument error					
VP-42	5	1.8	<	<	<	<	30
VP-43	5	<	<	<	<	<	5,000
VP-43D	5	<	<	<	<	<	31,000
VP-44	5	<	<	<	<	0.5	46,000



TABLE 2.3-17 (Cont.)

Sample	Depth (ft)	Pre-Benzene Peaks <sup>(c)</sup> (ppm)	Benzene (ppm)	Toluene (ppm)	Ethylbenzene (ppm)	Total Xylenes (ppm 0-xylene)	Methane (ppm)
VP-45	5	<	<	<	<	<	<
VP-46	5	<	<	<	<	<	12,000
VP-47	5	<	<	<	<	<	(b)
VP-48	5	<	<	<	<	<	<
VP-49	3	0.5	<	<	<	<	15
VP-49	5		no sample obtained--water encountered				
VP-50	5	0.4	<	<	<	<	4,100
VP-51	5	210	<	<	<	2.4	220,000
VP-52	5	<	<	1.7	<	3.2	66,000
VP-53	5	<	<	0.8	<	4.4	38,000
VP-54	5	1.2	<	<	<	3.0	(b)
VP-54D	5	1.3	<	0.6	<	2.4	210,000
VP-55	5	0.4	<	<	<	5.6	96,000
VP-56	5	<	<	<	<	5.2	16,000
VP-57	3	<	<	0.7	<	0.6	47,000
VP-58	5	<	<	<	<	<	72,000
VP-58D	5	<	<	<	<	<	60,000
VP-59	5	6.2	<	<	1.8	4.5	88,000
VP-60	3	0.8	<	0.8	<	7.3	15,000
VP-60	5		no sample obtained--probe refusal				
VP-61	5	6.0	<	110	<	16	32,000
VP-61	8	<	<	4.3	<	<	1,500
VP-62	5	<	<	<	<	<	<
VP-62D	5	<	<	<	<	<	5
VP-63	5	<	<	<	<	<	1,200
VP-64	5	<	<	<	<	<	75,000
VP-65	5	<	<	<	<	<	17,000
VP-66	3	<	<	<	<	<	20,000
VP-66	5	<	<	<	<	<	69,000
VP-66D	5	<	<	<	<	<	(a)
VP-67	3	<	<	<	<	<	62,000
VP-67	5		no sample obtained--probe refusal				
VP-68	5	<	<	2.6	<	1.3	46

TABLE 2.3-17 (Cont.)

Sample	Depth (ft)	Pre-Benzene Peaks <sup>(c)</sup> (ppm)	Benzene (ppm)	Toluene (ppm)	Ethylbenzene (ppm)	Total Xylenes (ppm O-xylene)	Methane (ppm)
VP-69	5	3.7	<	2.2	<	7.8	6,500
VP-70	5	0.3	<	<	<	0.8	42,000
VP-71	5	<	<	<	<	<	16,000
VP-72	5	<	<	<	<	<	27,000
VP-73	5	8.0	<	10	2.3	4.3	51,000
VP-74	5	3.9	<	11	1.3	3.7	36,000
VP-75	3	0.3	<	0.5	<	<	32,000
VP-75	5		no sample obtained--probe refusal				
VP-76	5	1.2	<	9.2	1.2	0.9	41,000
VP-77	5	<	<	0.5	1.3	1.1	48,000
VP-78	5	37	2.1	5.1	0.7	1.9	38,000
VP-79	5	<	<	<	<	<	35,000
VP-80	5	6.7	<	18	1.7	2.3	31,000
VP-80	8	3.1	<	9.8	1.4	1.7	41,000
VP-81	3	0.9	<	14	2.4	4.1	29,000
VP-81	5		no sample obtained--probe refusal				
VP-82	5	0.7	<	13	2.0	2.6	12,000
VP-83	3	0.7	<	0.4	1.2	1.6	48,000
VP-83	5		no sample obtained--probe refusal				
VP-84	5	<	<	<	<	<	29,000
VP-85	5	2.0	<	3.2	<	<	47,000
VP-86	5	3.5	<	5.0	0.6	<	36,000
VP-87	5	6.0	<	<	<	<	39,000
VP-88	5	3.4	<	<	<	<	35,000
VP-89	5	8.1	<	5.7	1.5	1.6	37,000
VP-90	5	3.9	2.2	4.2	<	<	33,000
VP-91	5	<	<	1.0	<	<	390
VP-92	5	0.5	<	4.2	1.9	2.5	69,000
VP-93	5	<	<	<	<	<	44,000
VP-94	5	<	<	1.3	<	<	29,000
VP-95	5	160	<	<	<	<	39,000
VP-95D	5	18	<	<	<	<	54,000
VP-96	5	7.4	<	6.2	<	<	42,000



TABLE 2.3-17 (Cont.)

Sample	Depth (ft)	Pre-Benzene Peaks <sup>(c)</sup> (ppm)	Benzene (ppm)	Toluene (ppm)	Ethylbenzene (ppm)	Total Xylenes (ppm O-xylene)	Methane (ppm)
VP-97	5	16	<	3.3	<	<	47,000
VP-98	5	2.8	<	5.9	<	<	13,000
VP-99	5	8.4	<	2.4	0.6	3.3	71,000
VP-100	5	2.0	<	21	1.1	1.5	39,000
VP-101	5	1.6	<	2.7	<	<	63,000
VP-102	5	1.6	<	2.7	<	<	58,000
VP-103	5	8.8	<	12.9	<	5.4	32,000
VP-103	8	6.3	<	9.7	<	1.4	31,000
VP-104	5	57	<	4.2	<	<	30,000
VP-105	5	<	<	<	<	<	27,000
VP-105D	5	12	<	2.0	<	<	43,000
VP-106	5	140	<	15	1.7	14	64,000
VP-107	5	17	<	0.9	<	<	20,000
VP-108	3	7	<	<	0.9	<	26,000
VP-108	5		no sample obtained--probe refusal				
VP-109	5	14	<	0.9	<	<	17,000
VP-110	5	2.3	<	<	<	2.0	34,000
VP-111	3	0.3	<	<	<	1.7	64,000
VP-111	5		no sample obtained--water encountered				

TABLE 2.3-18 CHLORINATED ALIPHATIC HYDROCARBON ANALYSIS RESULTS OF SOIL GAS SURVEY CONDUCTED AT THE FORT MEADE SANITARY LANDFILL

Sample	Depth (ft)	Methylene Chloride (ppm)	Trans-1,2- Dichloroethene (ppm)	Cis-1,2- Dichloroethene (ppm)	1,1,1- Trichloroethane (ppm)	Carbon Tetrachloride (ppm)	Trichloroethene (ppm)	Tetrachloroethene (ppm)
VP-1	2		no sample obtained--water encountered					
VP-1	3		no sample obtained--water encountered					
VP-2	2	<0.2	<0.4	<0.1	<0.1	<0.1	<0.1	<0.1
VP-2	3		no sample obtained--water encountered					
VP-3	3	<	<	<	<	<	<	<
VP-3	5	0.5	<	<	<	<	<	<
VP-3	8	<	<	<	<	<	<	<
VP-4	5	0.5	1.7	<	<	<	0.1	0.1
VP-4	8	0.4	1.3	<	<	<	0.1	<
VP-5	5	12	<	<	<	<	<	<
VP-6	5	0.3	<	<	<	<	<	<
VP-7	5	4.7	<	<	<	<	<	<
VP-8	5	150	<	<	<	<	<	<
VP-9	5	<	<	<	0.2	<	<	0.2
VP-10	5	<	<	<	0.9	<	0.2	0.2
VP-10	8	<	<	<	0.2	<	0.4	0.2
VP-11	5	<	<	<	0.1	<	0.1	0.3
VP-12	5	<	<	<	<	<	<	<
VP-13	5	<	<	<	0.2	<	0.1	<
VP-14	5	<	<	<	0.1	<	<	<
VP-14D	5	<	<	35	<	<	9.1	29
VP-15	5	<	<	23	<	<	10	30
VP-16	5	<	<	3.6	<	<	0.5	1.2
VP-17	5	<	<	<	<	<	<	0.3
VP-18	5	<	<	<	0.1	<	<	0.1
VP-18D	5	<	<	<	<	<	<	<
VP-19	5	1.8	<	0.4	<	<	0.1	0.3
VP-20	5	18	<	<	<	<	0.1	0.1
VP-21	5	5.3	3.1	<	<	<	0.3	0.7
VP-22	5	1.4	1.9	0.3	<	<	0.1	<
VP-23	5	8.1	0.5	0.5	<	<	0.2	<
VP-23D	5	1.9	12	12	<	<	4.1	4.1
VP-24	5	0.9	2.2	5.5	<	<	2.4	3.6
VP-25	5	<	<	<	<	<	<	<
VP-26	5	<	<	<	<	<	<	<
VP-27	5	1.7	<	<	<	<	<	<
VP-28	5	1.9	<	<	<	<	<	<
VP-28	5	0.9	<	<	<	<	<	<
VP-29	5	<	<	<	0.1	<	0.1	0.1

< Indicates that when detected, the concentrations encountered were below the employed detection limit  
i.e., methylene chloride 0.2 ppm, t-DCE 0.4 ppm, c-DCE 0.1 ppm, TCA 0.1 ppm, carbon tetrachloride 0.1 ppm, TCE 0.1 ppm, PCE 0.1 ppm.

D Duplicate sample.



TABLE 2.3-18 (Cont.)

Sample	Depth (ft.)	Methylene Chloride (ppm)	Trans-1,2- Dichloroethene (ppm)	Cis-1,2- Dichloroethene (ppm)	1,1,1- Trichloroethane (ppm)	Carbon Tetrachloride (ppm)	Trichloroethene (ppm)	Tetrachloroethene (ppm)
VP-30	5	2.7	<	<	<	<	<	<
VP-31	5	1.1	<	<	<	<	<	<
VP-32	5	2.2	<	<	<	<	<	<
VP-33	5	4.9	<	<	<	<	<	<
VP-34	3			no sample obtained--water encountered				
VP-34	5			no sample obtained--water encountered				
VP-35	3			no sample obtained--water encountered				
VP-35	5			no sample obtained--water encountered				
VP-36	3	0.3	<	<	<	<	<	<
VP-37	3	<	<	<	<	<	<	<
VP-38	3	1.1	<	<	<	<	<	<
VP-38D	3	19	<	<	<	<	<	<
VP-39	3	0.2	<	0.1	<	<	<	<
VP-40	3			<	<	<	<	<
VP-41	5	25	<	<	<	<	<	<
VP-42	5	<	<	<	<	<	<	<
VP-43	5	6.0	<	<	<	<	<	<
VP-43D	5	22	<	<	<	<	<	<
VP-44	5		no data obtained--instrument failure					<
VP-45	5	<	<	<	<	<	<	<
VP-46	5	1.7	<	<	<	<	<	<
VP-47	5	<	<	<	<	<	<	<
VP-48	5	<	<	<	<	<	<	<
VP-49	3	2.6	<	<	<	<	<	<
VP-49	5		no sample obtained--water encountered					<
VP-50	5	4.6	13	<	<	<	<	<
VP-51	5	450	<	<	0.4	<	0.1	<
VP-52	5	12	2.8	0.4	0.1	<	<	<
VP-53	5	1.8	<	<	<	<	<	<
VP-54	5	2.1	<	<	<	<	<	<
VP-54D	5	2.3	<	<	<	<	<	<
VP-55	5	29	13	3.4	0.2	<	0.1	1.0
VP-56	5	5.1	<	<	<	<	<	<
VP-57	3	8.8	<	<	<	<	<	<
VP-58	5	1.3	<	<	<	<	<	<
VP-58D	5	1.0	<	<	<	<	<	<
VP-59	5	2.0	<	<	<	<	<	<
VP-60	3	<	<	<	<	<	<	<
VP-60	5		no sample obtained--probe refusal					<
VP-61	5	2.6	1.5	<	<	<	<	<
VP-61	8	2.4	<	<	<	<	<	<
VP-62	5	1.4	<	<	<	<	<	<
VP-62D	5	1.7	<	<	<	<	<	<
VP-63	5	1.7	<	<	<	<	<	<
VP-64	5	3.5	<	<	<	<	<	<
VP-65	5	4.7	<	<	<	<	<	<

TABLE 2.3-18 (Cont.)

Sample	Depth (ft.)	Methylene Chloride (ppm)	Trans-1,2- Dichloroethene (ppm)	Cis-1,2- Dichloroethene (ppm)	1,1,1- Trichloroethane (ppm)	Carbon Tetrachloride (ppm)	Trichloroethene (ppm)	Tetrachloroethene (ppm)
VP-66	3	8.2	<	<	<	<	<	<
VP-66	5	<	<	<	<	<	<	<
VP-66D	5	2.7	<	<	<	<	<	<
VP-67	3	3.2	<	<	<	<	<	<
VP-67	5	<	<	no sample obtained--water encountered	<	<	<	<
VP-68	5	2.5	<	<	<	<	<	<
VP-69	5	<	<	<	<	<	<	<
VP-70	5	<	<	<	<	<	<	<
VP-71	5	1.0	<	<	<	<	<	<
VP-72	5	<	<	<	<	<	<	<
VP-73	5	<	5.2	<	<	<	<	0.1
VP-74	5	<	1.2	<	0.3	<	<	0.1
VP-75	3	<	0.8	<	<	<	<	<
VP-75	5	<	<	no sample obtained--probe refusal	<	<	<	<
VP-76	5	<	4.2	0.1	<	<	<	<
VP-77	5	0.5	<	<	<	<	<	<
VP-78	5	<	0.6	<	<	<	<	<
VP-79	5	<	<	0.1	<	<	<	<
VP-80	5	14	7.0	<	<	<	0.2	0.3
VP-80	8	4.2	0.7	<	0.1	<	<	0.1
VP-81	3	3.6	<	<	<	<	<	0.1
VP-81	5	<	<	no sample obtained--probe refusal	<	<	<	<
VP-82	5	1.2	<	<	<	<	<	<
VP-83	3	1.9	0.8	<	<	<	<	<
VP-83	5	<	<	no sample obtained--probe refusal	<	<	0.1	<
VP-84	5	<	<	<	<	<	0.1	0.1
VP-85	5	<	<	<	<	<	0.1	0.3
VP-86	5	<	<	<	<	<	<	0.1
VP-87	5	4.5	<	<	<	<	<	<
VP-88	5	220	<	<	<	<	1.3	0.4
VP-89	5	200	5.7	<	0.1	<	<	0.1
VP-90	5	<	<	<	<	<	<	<
VP-91	5	22	28	<	<	<	<	<
VP-92	5	16	<	<	<	<	<	<
VP-93	5	<	<	<	<	<	<	<
VP-94	5	1.4	1.1	<	<	<	0.1	<
VP-95	5	7.4	<	<	<	<	<	<
VP-95D	5	<	<	<	<	<	<	<
VP-96	5	2.4	<	<	<	<	<	<
VP-97	5	25	<	5.9	<	<	<	<
VP-98	5	8.7	<	<	0.1	<	<	<
VP-99	5	45	19	<	0.1	<	0.1	0.1
VP-100	5	4.2	<	<	<	<	<	<
VP-101	5	3.8	1.8	<	<	<	<	<
VP-102	5	37	<	<	<	<	1.8	3.6
VP-103	5	<	1.7	<	0.4	<	<	0.2



TABLE 2.3-18 (Cont.)

Sample	Depth (ft)	Methylene Chloride (ppm)	Trans-1,2- Dichloroethene (ppm)	Cis-1,2- Dichloroethene (ppm)	1,1,1'- Trichloroethane (ppm)	Carbon Tetrachloride (ppm)	Trichloroethene (ppm)	Tetrachloroethene (ppm)
VP-103	8	<	2.7	<	0.2	<	0.1	0.5
VP-104	5	1.8	2.4	<	<	<	<	0.2
VP-105	5	0.5	<	<	<	<	0.1	0.1
VP-105D	5	6.3	9.5	<	<	<	0.1	0.2
VP-106	5	37	5.7	<	<	<	<	<
VP-107	5	7.3	2.9	<	<	<	0.2	0.3
VP-108	3	77	4.0	<	0.1	<	0.1	0.3
VP-108	5			no sample obtained--probe refusal				
VP-109	5	210	30	0.5	0.8	<	0.2	0.4
VP-110	5	1.5	<	0.1	<	<	<	<
VP-111	3	0.5	4.4	0.2	<	<	<	<
VP-111	5			no sample obtained--water encountered				

TABLE 2.3-19 FORT MEADE ACTIVE SANITARY LANDFILL PASSIVE SOIL GAS SAMPLING, JUNE 1991

Sample	1,1-Dichloroethane	Trans-1,2-Dichloroethene	Compound (ng/m <sup>3</sup> /day)		Toluene	Ethylbenzene	Xylenes
			Trichloroethene	Benzene			
PS-1	6.45 x 10 <sup>-4</sup>	2.43 x 10 <sup>-3</sup>	1.14 x 10 <sup>-3</sup>	2.11 x 10 <sup>-3</sup>	3.41 x 10 <sup>-4</sup>	1.45 x 10 <sup>-3</sup>	5.88 x 10 <sup>-4</sup>
PS-1D	6.45 x 10 <sup>-4</sup>	2.74 x 10 <sup>-3</sup>	9.83 x 10 <sup>-3</sup>	1.66 x 10 <sup>-3</sup>	5.11 x 10 <sup>-4</sup>	1.35 x 10 <sup>-3</sup>	7.84 x 10 <sup>-4</sup>
PS-2	<3.23 x 10 <sup>-4</sup>	2.59 x 10 <sup>-3</sup>	1.21 x 10 <sup>-3</sup>	<3.02 x 10 <sup>-4</sup>	3.41 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	3.92 x 10 <sup>-4</sup>
PS-3	<3.23 x 10 <sup>-4</sup>	<3.04 x 10 <sup>-4</sup>	<3.45 x 10 <sup>-4</sup>	<3.02 x 10 <sup>-4</sup>	<3.41 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>
PS-4	9.68 x 10 <sup>-4</sup>	4.56 x 10 <sup>-3</sup>	1.04 x 10 <sup>-3</sup>	1.21 x 10 <sup>-3</sup>	<3.41 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>
PS-5	<3.23 x 10 <sup>-4</sup>	<3.04 x 10 <sup>-4</sup>	<3.45 x 10 <sup>-4</sup>	<3.02 x 10 <sup>-4</sup>	<3.41 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>
PS-6	<3.23 x 10 <sup>-4</sup>	<3.04 x 10 <sup>-4</sup>	6.90 x 10 <sup>-4</sup>	<3.02 x 10 <sup>-4</sup>	<3.41 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>
PS-7	<3.23 x 10 <sup>-4</sup>	<3.04 x 10 <sup>-4</sup>	3.45 x 10 <sup>-4</sup>	<3.02 x 10 <sup>-4</sup>	<3.41 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>
PS-8	<3.23 x 10 <sup>-4</sup>	<3.04 x 10 <sup>-4</sup>	1.04 x 10 <sup>-3</sup>	<3.02 x 10 <sup>-4</sup>	<3.41 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>
PS-8D	<3.23 x 10 <sup>-4</sup>	<3.04 x 10 <sup>-4</sup>	8.63 x 10 <sup>-4</sup>	<3.02 x 10 <sup>-4</sup>	<3.41 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>
PS-9	<3.23 x 10 <sup>-4</sup>	<3.04 x 10 <sup>-4</sup>	<3.45 x 10 <sup>-4</sup>	<3.02 x 10 <sup>-4</sup>	<3.41 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>
PS-10	<3.23 x 10 <sup>-4</sup>	<3.04 x 10 <sup>-4</sup>	6.90 x 10 <sup>-4</sup>	<3.02 x 10 <sup>-4</sup>	<3.41 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>
PS-11	<3.23 x 10 <sup>-4</sup>	4.56 x 10 <sup>-4</sup>	1.95 x 10 <sup>-3</sup>	<3.02 x 10 <sup>-4</sup>	<3.41 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>
PS-12	<3.23 x 10 <sup>-4</sup>	6.09 x 10 <sup>-4</sup>	6.90 x 10 <sup>-4</sup>	5.29 x 10 <sup>-3</sup>	5.11 x 10 <sup>-4</sup>	1.0 x 10 <sup>-3</sup>	2.74 x 10 <sup>-3</sup>
Field Blank	<3.23 x 10 <sup>-4</sup>	<3.04 x 10 <sup>-4</sup>	<3.45 x 10 <sup>-4</sup>	<2.96 x 10 <sup>-4</sup>	<3.24 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	<3.66 x 10 <sup>-4</sup>
Method Blank	<3.23 x 10 <sup>-4</sup>	<3.04 x 10 <sup>-4</sup>	<3.45 x 10 <sup>-4</sup>	<2.96 x 10 <sup>-4</sup>	<3.24 x 10 <sup>-4</sup>	<3.92 x 10 <sup>-4</sup>	<3.66 x 10 <sup>-4</sup>

D - Duplicate.



TABLE 2.3-19 (Extended)

Sample	Compound (mg/m <sup>3</sup> /day)				
	Tetrachloroethene	Chloroform	1,1,1-Trichloroethane	1,2-Dichloropropane	Chlorobenzene
PS-1	<3.78 x 10 <sup>-4</sup>	<3.20 x 10 <sup>-4</sup>	<3.61 x 10 <sup>-4</sup>	<3.50 x 10 <sup>-4</sup>	<3.65 x 10 <sup>-4</sup>
PS-1D	<3.78 x 10 <sup>-4</sup>	<3.20 x 10 <sup>-4</sup>	<3.61 x 10 <sup>-4</sup>	<3.50 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
PS-2	<3.78 x 10 <sup>-4</sup>	<3.20 x 10 <sup>-4</sup>	<3.61 x 10 <sup>-4</sup>	<3.50 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
PS-3	<3.78 x 10 <sup>-4</sup>	9.61 x 10 <sup>-4</sup>	5.42 x 10 <sup>-4</sup>	<3.50 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
PS-4	<3.78 x 10 <sup>-4</sup>	<3.20 x 10 <sup>-4</sup>	<3.61 x 10 <sup>-4</sup>	<3.50 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
PS-5	<3.78 x 10 <sup>-4</sup>	9.81 x 10 <sup>-4</sup>	5.31 x 10 <sup>-4</sup>	<3.50 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
PS-6	<3.78 x 10 <sup>-4</sup>	3.20 x 10 <sup>-4</sup>	3.07 x 10 <sup>-4</sup>	<3.50 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
PS-7	3.78 x 10 <sup>-4</sup>	8.01 x 10 <sup>-4</sup>	9.57 x 10 <sup>-4</sup>	<3.50 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
PS-8	<3.78 x 10 <sup>-4</sup>	<3.20 x 10 <sup>-4</sup>	1.62 x 10 <sup>-3</sup>	<3.50 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
PS-8D	<3.78 x 10 <sup>-4</sup>	<3.20 x 10 <sup>-4</sup>	2.17 x 10 <sup>-3</sup>	<3.50 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
PS-9	<3.78 x 10 <sup>-4</sup>	<3.20 x 10 <sup>-4</sup>	8.30 x 10 <sup>-3</sup>	<3.50 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
PS-10	<3.78 x 10 <sup>-4</sup>	<3.20 x 10 <sup>-4</sup>	5.24 x 10 <sup>-3</sup>	<3.50 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
PS-11	5.11 x 10 <sup>-3</sup>	<3.20 x 10 <sup>-4</sup>	3.61 x 10 <sup>-4</sup>	8.76 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
PS-12	3.78 x 10 <sup>-4</sup>	<3.20 x 10 <sup>-4</sup>	<3.61 x 10 <sup>-4</sup>	3.50 x 10 <sup>-4</sup>	2.12 x 10 <sup>-3</sup>
Field Blank	<3.78 x 10 <sup>-4</sup>	<3.20 x 10 <sup>-4</sup>	5.41 x 10 <sup>-4</sup>	<3.50 x 10 <sup>-4</sup>	<3.86 x 10 <sup>-4</sup>
Method Blank	<3.78 x 10 <sup>-4</sup>	<3.20 x 10 <sup>-4</sup>	<3.61 x 10 <sup>-4</sup>	<3.50 x 10 <sup>-4</sup>	1.93 x 10 <sup>-4</sup>

TABLE 2.3-20

ABUNDANCE OF BENTHIC MACROINVERTEBRATES COLLECTED FROM  
BIOLOGICAL STATIONS, REMEDIAL INVESTIGATION SITES, FORT  
MEADE, 20 MARCH - 4 APRIL 1991

	<u>LP4</u>	<u>Stations</u>		<u>*RHB1</u>
		<u>*SLF1</u>	<u>*SLF2</u>	
Tricladida				8
Nematoda		1		
Lumbriculidae		1		
<u>Nais behningi</u>	2			
<u>N. bretscheri</u>	3			
<u>N. communis</u>	3			
<u>N. pardalis</u>	5			1
<u>N. variabilis</u>	1			
Imm. tub. w/o cap. chaetae	5	1	2	1
<u>Limnodrilus hoffmeisteri</u>		6		
<u>Hyalella azteca</u>		1		
<u>Ephemerella</u> N.	1			
<u>Stenonema modestum</u> N.	2			
<u>Calopteryx</u> N.		1		
<u>Ischnura</u> N.			1	
<u>Cordulegaster</u> N.		1		
Nemouridae N.			13	
<u>Corydalus cornutus</u> L.	1			
<u>Helichus</u> L.	1			
Dytiscidae L.			1	
<u>Macronychus glabratus</u> L.	1			
<u>Berosus</u> L.	1			
Hydropsychidae L.				7
<u>Cheumatopsyche</u> L.		9	3	6
<u>Hydropsyche</u> L.	2			
<u>H. betteni</u> L.		5	1	46
<u>Ironoquia</u> L.		1		
Empididae L.	1			
<u>Hemerodromia</u> L.				3
<u>Chaoborus</u> L.		1		
Chironomidae P.	13	3		
<u>Cryptochironomus</u> L.		1		
<u>Polypedilum convictum</u> L.		2		49
<u>P. illinoense</u> L.	1			
<u>P. scalaenum</u> L.		2		
<u>Pseudochironomus</u> L.				3
<u>Rheotanytarsus</u> L.				1
<u>Tanytarsus</u> L.				8
Diamesinae L.	26			
<u>Cricotopus</u> L.			1	

Note: Total number of organisms is based on a 100-organism subsample.

\* Stations located near the Active Sanitary Landfill.



TABLE 2.3-20 (Cont.)

	<u>LP4</u>	<u>Stations</u>		<u>*RHB1</u>
		<u>*SLF1</u>	<u>*SLF2</u>	
<u>C. bicinctus</u> L.	2	7	7	3
<u>C. tremulus</u> L.	18	21	9	10
<u>Orthocladius</u> L.	4	3	5	
<u>Symposiocladius</u> L.	1			
<u>Thienemannimyia</u> series L.		5	1	1
Simuliidae P.	1		6	7
<u>Prosimulium</u> L.	1			
<u>Simulium</u> L.			65	19
Tabanidae L.		3		
Tipulidae L.		1		
<u>Antocha</u> L.		1		
<u>Tipula</u> L.		1		1
Lymnaeidae		1		
<u>Physella</u>		2	7	1
<u>Pisidium</u>				1
Total Number of Taxa	21	23	12	17
Total Number of Organisms	96	81	122	178

TABLE 2.3-21

PHYSICOCHEMICAL PARAMETERS MEASURED AT BIOLOGICAL STATIONS,  
REMEDIAL INVESTIGATION SITES, FORT MEADE, 20 MARCH - 4 APRIL  
1991

<u>Station</u>	<u>Temperature</u> <u>(°C)</u>	<u>pH</u>	<u>Dissolved</u> <u>Oxygen (mg/L)</u>	<u>Conductivity</u> <u>(μmhos/cm)</u>
LP4	10.9	8.1	10.0	293
*SLF1	11.9	7.8	10.4	601
*SLF2	12.1	7.9	9.9	494
*RHB1	9.4	7.8	10.8	273

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\* Stations located near the Active Sanitary Landfill.



TABLE 2.3-22

SUMMARY OF THE HABITAT QUALITY AT BIOLOGICAL STATIONS,  
REMEDIAL INVESTIGATION SITES, FORT MEADE, 20 MARCH - 4 APRIL  
1991

<u>Habitat Parameters</u>	<u>LP4</u>	<u>Station</u>		<u>RHB1<sup>(a)</sup></u>
		<u>SLF1<sup>(a)</sup></u>	<u>SLF2<sup>(a)</sup></u>	
Primary Parameters				
Substrate	15	5	13	8
Embeddedness	10	6	10	8
Velocity/Depth	16	9	15	16
Secondary Parameters				
Channel Alteration	10	3	7	6
Scouring/Deposition	7	5	6	6
Run/Bend	12	5	7	11
Tertiary Parameters				
Bank Stability	5	5	5	7
Bank Vegetation	4	7	7	9
Streamside Cover	6	7	7	8
Total Score	85	52	77	79

(a) Stations located near the Active Sanitary Landfill.

TABLE 2.3-23 ABUNDANCE AND DISTRIBUTION OF FISHES COLLECTED FROM STREAMS  
IN THE VICINITY OF THE ASL, FORT MEADE, 20 MARCH 1991

<u>Species</u>	<u>SLF1</u>	<u>Station</u>		<u>Total</u>
		<u>SLF2</u>	<u>RHB1</u>	
American eel			3	3
Eastern mudminnow	8			8
Redfin pickerel		1		1
Chain pickerel			1	1
Golden shiner		1		1
Swallowtail shiner			6	6
Blacknose dace	1	1		2
Fallfish		2		2
Creek chubsucker			5	5
Brown bullhead			1	1
Margined madtom			1	1
Bluespotted sunfish		11	10	21
Redbreast sunfish		5	6	11
Pumpkinseed	29	23	6	58
Bluegill	1	8	12	21
Largemouth bass			1	1
Total Specimens	39	52	52	143
Total Species	4	8	11	16



## 2.4 CONTAMINANT FATE AND TRANSPORT

### 2.4.1 Potential Routes of Migration

Soil, surface water, stream sediment, ground water, and leachate samples were collected and analyzed to assess the existence and nature of contaminants and the potential for their migration. The surficial soil (Section 2.3.2) surface water and stream sediment analyses (Section 2.3.3) did not show evidence of contamination.

The ground water monitoring network was developed to assess the water quality and potential routes of contaminant migration from the ASL into the water-table aquifer and the uppermost confined aquifer. Based on the historical data and the analytical results obtained during this study, the ASL is a source of volatile organic and pesticide contamination in the water-table aquifer (Section 2.3.4).

This contamination was detected in the ground water and leachate seep samples primarily along the western, southern, and eastern boundaries of the site. The water-table aquifer and the contaminants emanating from the central region of the site are primarily discharging to surface streams and leachate seeps along the western boundary, thus limiting to some extent the migration of contaminants in the water-table aquifer in this direction. Along the southern and eastern boundary the water-table aquifer and surface topography slopes to the south and southeast, respectively. There are no perennial surface streams in proximity to the site along these boundaries.

The data indicate that the ASL is not a source of VOC or metals contamination in the lower Patapsco aquifer. Some pesticide compounds were detected at low levels in a number of the samples collected from the lower Patapsco wells.

### 2.4.2 Contaminant Source and Persistence

The earliest analytical data set for VOCs dates back to February 1985 and identified low levels of VOCs in the water-table aquifer along the eastern boundary. Inorganic data were obtained from the limited monitoring well network as early as December 1982. The following discussion will focus on volatile organic compounds because of the identified concern.

Organic compounds differ widely in their solubility, from infinitely miscible polar compounds to extremely low-solubility compounds such as polynuclear aromatic hydrocarbons (PAHs). The two classes of volatile organic compounds detected at the ASL include halogenated aliphatic hydrocarbons and monocyclic

aromatics. The water solubility of a substance is a critical property affecting environmental fate; highly soluble chemicals can be leached from wastes and soil and are mobile in both surface water and ground water. Both of these classes of compounds have moderate to low relative solubilities (less than 1 percent). These solubilities, however, are high (less than 100,000 mg/L) with respect to established MGLs (e.g., benzene and TCE at 5  $\mu\text{g/L}$ ). The dissolved volatile organic compound concentrations encountered in the ground water range from ND to 121  $\mu\text{g/L}$  for 1,3-dimethylbenzene. The highest benzene value was detected in the MW-19 sample at 12.4  $\mu\text{g/L}$ . At these concentrations, no nonaqueous phases are thought to exist.

Volatilization of a compound from environmental media will depend on its vapor pressure, water solubility, and diffusion coefficient. For estimating releases from water to air, the Henry's Law constant (the partition coefficient which expresses the ratio of the chemical concentration between air and water at equilibrium) is more appropriate than vapor pressure alone and is frequently measured for volatile chemicals.

The Henry's Law constant can be estimated for chemicals of low aqueous solubility (less than a few percent) by the ratio of vapor pressure and solubility at similar temperatures (Mackay and Shiu 1981). Compounds with Henry's Law constants in the range of  $10^{-3}$  atm  $\text{m}^3/\text{mole}$  and larger (benzene, toluene, and ethylbenzene) can be expected to volatilize readily from water; those with values ranging from  $10^{-3}$  to  $10^{-5}$  atm  $\text{m}^3/\text{mole}$  are associated with significant but lesser volatilization, while compounds with values less than  $10^{-5}$  atm  $\text{m}^3/\text{mole}$  volatilize from water only to a limited extent (Lyman et al. 1982).

The organic carbon partition coefficient ( $K_{oc}$ ) reflects the propensity of a compound to adsorb to the organic carbon found in soil. The higher the  $K_{oc}$  value, the greater a chemical's tendency to adsorb to soil organic carbon. In addition to organic carbon, sorption to soil is also a function of the surface area of the soil particles as well as the size, shape, structure, and surface area of the adsorbing molecule.

#### 2.4.3 Contaminant Migration in the Water-Table Aquifer

Section 2.2.1 provides information on the hydrogeology of the site and ground-water movement in the water-table (upper Patapsco) and confined (lower Patapsco) aquifers. Ground-water contour maps (Figures 2.2-3 and 2.2-4) were developed for both of these aquifers based on water-level measurements obtained from the monitoring wells installed during this study and the wells and piezometers that previously existed at the site.



The water-table contour map shows that for the majority of the site the water table slopes to the west along the western boundary of the fill consistent with the surface water flow in this area. The slope of the water table and direction of ground-water flow in the water-table aquifer along the southern and eastern boundaries of the fill area are affected by the natural topography and the placement of the two 10-ft lifts of waste in this area. Along the southern boundary, the water table slopes to the south-southwest, and along the eastern boundary the water-table slopes to the east-southeast.

#### Ground-Water Model

The initial ground-water modeling effort included in the draft RI report (EA 1990) involved the water-table aquifer flow field and contaminant migration in the vicinity of the ASL site and utilized MOC, a two-dimensional solute transport model developed by L.F. Konikow and J.D. Bredehoeft (1978) and updated by Konikow (1989). In this report the ground-water modeling was performed using MODFLOW to calibrate the flow field; the resultant boundary conditions were then used to execute MOC, the USGS two-dimensional solute transport model.

In addition, the revised model grid network was enlarged to include the area southeast of the ASL, which was not included in the initial model runs. This area was included in the revised model in an attempt to project ground-water flow and contaminant migration in this direction because of the lack of any direct measurements of hydraulic heads in this area. In the absence of any direct water-level measurements, surface topography, surface drainage patterns, and the available geologic information were utilized to interpret ground-water flow in this area.

As stated, the flow field in the water-table aquifer was calibrated with MODFLOW. MODFLOW is a modular, three-dimensional, finite difference ground water flow model developed by the USGS (McDonald and Harbaugh 1984). In applying the model to the site, a two-dimensional cell grid was set up, the same as would be used for the solute transport model. The use of MODFLOW for the flow field has several advantages over the MOC solute transport model. Among these is the treatment of the aquifer hydraulic conductivity. MODFLOW inputs hydraulic conductivity (ft/sec) while MOC uses transmissivity (ft<sup>2</sup>/sec). MODFLOW calculates the transmissivity from the hydraulic conductivity and aquifer thickness. Thus, as the ground-water surface varies across the site, the transmissivity in MODFLOW is automatically adjusted.

#### 2.4.3.1 Ground-Water Flow

The ASL site was divided into a square grid of 200-ft cells. The ground water grid network as it relates to the ASL cell boundaries and FGGM boundary is illustrated in Figure 2.4-1. The actively modeled portion consisted of 21 east-west columns and 34 north-south rows. This was an increase from the 16 x 18 cell grid used in the previous report. An attempt was made to extend the grid beyond the landfill in all directions to provide coverage of potential plume movement. This identification system is used throughout the modeling section.

In Table 2.4-1, the active cells have a 0 code while constant head boundaries have a 1 code. Codes 2-5 designate the landfill area. Codes 2 and 3 represent the location of the 10-ft lifts while codes 4 and 5 represent areas where only trench-fill activity has taken place. These codes will be defined and discussed further in Section 2.4.3.2.

Along the northwest side of the site a constant head boundary was established along the streambed. A constant head boundary also extends along the small stream that enters the site from the west, including the two small ponds and the stream's north and south branches. An additional stream designated as a constant head boundary enters from the southwest. Along the remainder of the west side, the constant head boundary was fixed at a below-grade elevation consistent with the gradient from the landfill to the streambed, which lies further to the west.

Beyond the site to the southeast the land elevation increases from an approximately 164-ft elevation in the vicinity of the railroad tracks to a +200-ft elevation approximately 2,000 ft further southeast. The surface of the water-table aquifer would also be expected to rise to the southeast. Thus, the water-table surface that decreases from the landfill in the southeast direction is a local feature relative to the larger scale water-table surface. A constant head boundary was imposed across the southeast corner of the site at the location where the ground-water elevation was considered to trend upwards relative to the land surface.

To the northeast the model extended to a ridge line that acts as a ground water flow divide. The north and northeast portions of the model were treated as a no-flow boundary, and elevations were allowed to seek their natural levels resulting from recharge and surrounding boundary interaction.

For model calibration, MODFLOW was set up to represent steady state flow under existing conditions resulting from annual average boundary values. In order to compare the model to the observed well elevations, the observed elevations



were averaged over the October 1989 - February 1991 period. The resulting annual average well elevations are presented in Table 2.4-2.

The MODFLOW model was fitted to the observed well elevations using hydraulic conductivity and recharge as calibration parameters. Initially, an average hydraulic conductivity of  $6.2 \times 10^{-5}$  ft/sec was used for each cell along with an effective porosity of 0.3. The initial recharge rate was 6 in./year.

MODFLOW calculates the aquifer thickness on a cell-by-cell basis with respect to the underlying confining surface. The elevation of the top of the middle confining layer was established based on the data obtained from the soil borings and is provided in Table 2.4-3. These values show that this layer slopes to the southeast and thins to the west of the landfill where it outcrops to the west of the model boundary. An erosional valley that is oriented east-west cuts through the ridge in the vicinity of the east-west stream.

During model calibration a number of ground-water features were addressed, including

- the local decrease in elevation southeast of the lifts,
- relatively low elevation at wells MW-13 and MW-18, and
- relatively steep gradients along the lifts.

In fitting these features, hydraulic conductivity and recharge were varied for individual model cells. The resulting hydraulic conductivity and recharge values are provided in Tables 2.4-4 and 2.4-5, respectively.

The area southeast of the ASL and outside of the FGGM boundary is drained by an intermittent stream that carries surface water flow from the properties east of the landfill in a southwest direction toward and onto the FGGM property south of the landfill. The constant head cell elevation established below this intermittent stream channel was set at 148 ft (Cell 11, 26) compared to the observed water-level elevations in MW-14 (148.6 ft) and MW-19 (149.6 ft) located along the southeast boundary of the ASL and FGGM.

MW-13 and MW-18 are located north of MW-14 and MW-19 along the eastern boundary of the ASL. The observed water-level elevations at MW-13 and MW-18 are 145.1 and 144.3 ft, respectively. The downgradient flow direction from this area is regarded to be to the west following the direction of the original streambed before the buildup of Cells 1 and 2. The constant head cell elevation at the farthest extent of the perennial stream from the west was 140 ft (Cell 12, 15). In order to transport the required flow from east

to west in the central region of the site, the hydraulic conductivity was increased above the average site value by a factor of 5 in the area southeast of MW-14 and MW-19, and by a factor of 10 between MW-13 and MW-18 and the headwaters of the east-west stream. The highest hydraulic conductivity value from the slug tests, a factor of 3.2 above the site average, was at MW-2, also on the east side of the site.

Very steep ground-water gradients exist in several portions of the site, for example, between MW-5 and MW-6 and between MW-8 and MW-9. In order to maintain these gradients, the hydraulic conductivity was reduced below the average value in order to hold water at the upgradient location while the hydraulic conductivity was increased between the downgradient well and the nearby stream. A hydraulic conductivity of one-tenth the average value was used in the vicinity of MW-5 and MW-9. In these areas, the aquifer is fairly thin relative to the underlying middle confining layer, and the presence of a clay lens would have a greater effect on the vertical average hydraulic conductivity than it would in a thicker region. The final hydraulic conductivities, represented as the multiplier applied to the site average, are provided in Table 2.4-4.

A recharge rate of 6 in./year was initially used over the entire site, based on the 1990 report. During the present calibration, the recharge was reduced to 2 in./year in selected areas beyond the landfill. The recharge was reduced along the east side of the model including the vicinity of MW-13 and MW-18 and between the lifts and eventual rise in the land surface to the southeast. This action further facilitated fitting the observed heads in the two regions where the hydraulic conductivities were increased.

Recharge was also reduced in the central area of the site between Cells 1 and 3. This area is adjacent to the ponds and the north and south branches of the stream. The presence of these features would result in increased direct runoff and reduced recharge. The recharge rates used in the calibrated model are provided in Table 2.4-5.

The water-table elevations resulting from calibrating MODFLOW to the ASL site are provided in Table 2.4-6 and displayed in Figure 2.4-2. The difference between observed and predicted water surface elevations at each well is provided in Table 2.4-2. Most wells where the deviation in elevation exceeded 1 ft were along the edge of the lifts with steep local gradients. The predicted elevation is sensitive to the well's location along the gradient. These steep gradients are a function of the relative thickness of the water-table aquifer and the depth to the middle confining layer associated with the east-west erosional valley parallel to the stream channel. The depth to the middle confining layer at MW-5 and MW-9 was less than 5 ft



and 10 ft, respectively, whereas the depth to this layer at the MW-7 well cluster was approximately 17 ft. MW-5 and MW-9 are located outside of the erosional stream valley. The MW-7 cluster is located in the central region of this valley.

The observed water-level elevation in MW-6 is 5.6 ft lower than the MW-5 water-level elevation, which is significant given the short distance separating these wells. The observed MW-8 water-level elevation is 17.5 ft lower than the MW-9 water-level elevation, which is approximately 500 ft from MW-8. The predicted elevations at MW-6 and MW-8, which are 1.7 and 1.1 ft higher than observed, are not large compared to the elevation change to the neighboring cell. MW-6 and MW-8 are located within the erosional stream valley, and the water-table aquifer is thicker in the vicinity of these wells compared to MW-5 and MW-9, which explains the steep gradients.

The ground-water elevations in the vicinity of MW-13 and MW-18 are several feet lower than neighboring wells at MW-2 and MW-17. This area was regarded to flow west along a relatively shallow gradient. Elevations at these two wells are overpredicted by approximately 1 ft to help provide a gradient for this flow. This westerly flow component is not consistent with the observed 151-ft elevation at MW-15, indicating that it may be perched.

In Table 2.4-2, MW-10 is also underpredicted by 3 ft. The boring logs indicate that MW-10 may be perched, explaining the higher observed elevations.

#### 2.4.3.2 Ground-Water Transport

The MOC solute transport model was set up using the flow field resulting from the MODFLOW calibration. The identical 200-ft cell grid, constant head boundaries, and recharge rates were used. While MODFLOW requires the hydraulic conductivity (ft/sec), MOC requires the transmissivity (ft<sup>2</sup>/sec). The transmissivity for each cell was calculated by multiplying the hydraulic conductivity by the aquifer thickness. The aquifer thickness was calculated by subtracting the top of clay (Table 2.4-3) from the predicted ground-water elevations (Table 2.4-6). The resulting steady state flow field in MOC is nearly identical to that in MODFLOW.

Trench-fill activity commenced at the site in 1958, proceeding from south to north, with the entire site consumed by 1976. From 1976 to date, multiple 10-ft lifts have been added to Cells 1 and 2. The northern portion of the site (Cell 3) has been inactive since the completion of the trench-fill operation. In order to model the landfill activity, cell codes were used to

delineate the spatial and temporal sequence. These codes (2, 3, 4, and 5) are indicated on the model grid in Table 2.4-1.

Preliminary MOC runs indicated that source concentration required to provide observed concentrations in the vicinity of Cell 3 (MW-4 and MW-6) is approximately one-tenth of the source concentration required in the vicinity of the lifts in Cells 1 and 2. For the purposes of modeling the historical development of the landfill, the source concentration associated with Cell 3 will be assumed to be applicable over the rest of the site (Cells 1 and 2) during the trench-fill period. A leachate concentration of 10 units was assumed to be associated with the trench fill, and a leachate concentration of 100 units was assumed to be associated with the lifts. A summary of source concentration by cell code for year ranges during the historical development of the ASL site is provided below.

<u>Year Range</u>	<u>Number Years</u>	<u>Source Concentration for Cell Code</u>			
		<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
1960-1969	10	10	10	10	0
1970-1976	7	10	10	10	10
1977-1984	8	100	10	10	10
1985-1990	6	100	100	10	10

The predicted ground-water concentrations in 1976 at the end of the trench-fill phase are presented in Table 2.4-7. Relative to a distributed leachate source concentration of 10 units in all three cells, concentrations of 1-2 units are reaching the stream along the northwest boundary and the north and south stream branches in the center of the site.

The predicted ground-water concentrations for present conditions, 1990, are presented in Table 2.4-8 and Figure 2.4-3. This scenario has had a 100-unit source in Cell 1 since 1977 and in a portion of Cell 2 since 1985. The concentration reaching the stream at the northwest boundary and the north branch of the stream in the middle of the site doubled from 2 to 4 units between 1976 and 1990. These two areas are in the vicinity of the continued 10-unit source at Cell 3. Concentrations reaching the south branch of the stream directly downgradient from the 100-unit source in Cell 1 increased from 2 units to 11-17 units. Concentrations for 1990 within Cell 1 have increased to 60 units while the highest concentration within Cell 2 is only 24 units. The lower Cell 2 concentrations are due to the 100-unit source being present only since 1985 and to the greater ground-water flow through this area providing dilution.



The predicted 1990 leachate plume concentrations were compared to the observed benzene concentrations. Benzene had been observed at the greatest number of wells, 13 out of 20. A comparison of predicted and observed concentrations should provide a scaling relationship between the assumed 100-unit and actual source strength. A regression between predicted and observed concentrations has a slope of approximately 0.3. This indicates that the 100-unit source should be scaled to 30 ppb to represent the observed benzene plume.

The 1990 predicted concentrations scaled by 0.3 to represent benzene are presented in Table 2.4-9 and Figure 2.4-4. The 30 ppb benzene source results in 18 ppb concentrations in Cell 1 and 7 ppb concentrations in Cell 2. The 3 ppb benzene source in Cell 3 ( $10 \times 0.3$ ) results in 1.5-2.7 ppb concentrations within the cell. Table 2.4-9 indicates that a benzene concentration of 1.4 ppb is reaching the stream at the northwest boundary and a concentration of 3-5 ppb is reaching the stream branch just north of Cell 1.

The discussion to this point has not included effects from environmental degradation. In an aerobic environment benzene is subject to biodegradation. A biodegradation half-life has been reported on the order of 0.3 year (Olsen and Davis 1990). This half-life assumes that both oxygen and the appropriate bacterial population are present. In a sanitary landfill, the presence of organic waste would be expected to deplete available oxygen in the ground water. The ground water would also be subject to re-aeration further down-gradient. Because of the non-ideal conditions present for benzene degradation at the FGGM site, a half-life greater than 0.3 year was warranted. A half-life of 2 years was selected for analysis. The MOC model was executed from 1960 to 1990 using the same historical development of the landfill as the previous case. The predicted concentrations in 1990 relative to the assumed 100/10 unit source were regressed against the observed benzene concentrations. The resulting regression slope was approximately 2.0. This indicates that the 100-unit source scales to a 200 ppb distributed benzene source.

The predicted 1990 benzene concentrations assuming a 2-year half-life are presented in Table 2.4-10 and Figure 2.4-5. With the inclusion of decay the assumed benzene source has increased from 30 to 200 ppb while the maximum concentration within Cell 1 has only increased from approximately 18 to 34 ppb. Concentrations reaching the stream at the northwest boundary and the north branch of the stream in the middle of the site have decreased from 1.4 ppb to less than 1 ppb. However, concentrations are slightly higher at the stream branch just north of Cell 2.

Site closure has been proposed for Cell 1, which would consist of constructing a cap. This is anticipated to occur in 1993. The model was executed for an additional 20 years--to the year 2010--with recharge removed from Cell 1 (cell



code 2 and the southern five cells with cell code 3) in order to investigate this proposed scenario. It was assumed that 1990 model predictions are representative of 1993 conditions. The model was executed in the transient mode such that ground-water heads would adjust themselves to a new equilibrium distribution. The new steady state condition was reached in approximately 8 years, and ground-water elevations within the main portion of Cell 1 decreased by 1.3-1.7 ft. The water-table elevations in the year 2010 with no recharge to Cell 1 are provided in Table 2.4-11 and Figure 2.4-6.

Leachate plume concentrations in the year 2010 with no recharge to Cell 1, but with a continued 100-unit source in Cell 2 and a 10-unit source in Cell 3, are presented in Table 2.4-12 and Figure 2.4-7. A comparison of the 1990 case (Table 2.4-8, Figure 2.4-3) indicates that concentrations within Cell 1 have decreased from approximately 60 to 40 units, while at the fringe of the plume, the area associated with concentrations less than 2 units has expanded slightly.

The Cell 1 capping scenario was also executed to the year 2010 using a 2-year half-life. By the year 2010 the majority of Cell 1 had been reduced to a near zero concentration. The 10-year plume, year 2000, has been presented in Table 2.4-13 and Figure 2.4-8 when a remnant is still visible. Concentrations in Table 2.4-13 have been multiplied by 2.0 in order to scale to the benzene concentration distribution. The 34 ppb Cell 1 benzene concentrations presented in Table 2.4-10 for 1990 are reduced to 1 ppb after 10 years when the leachate source is turned off.

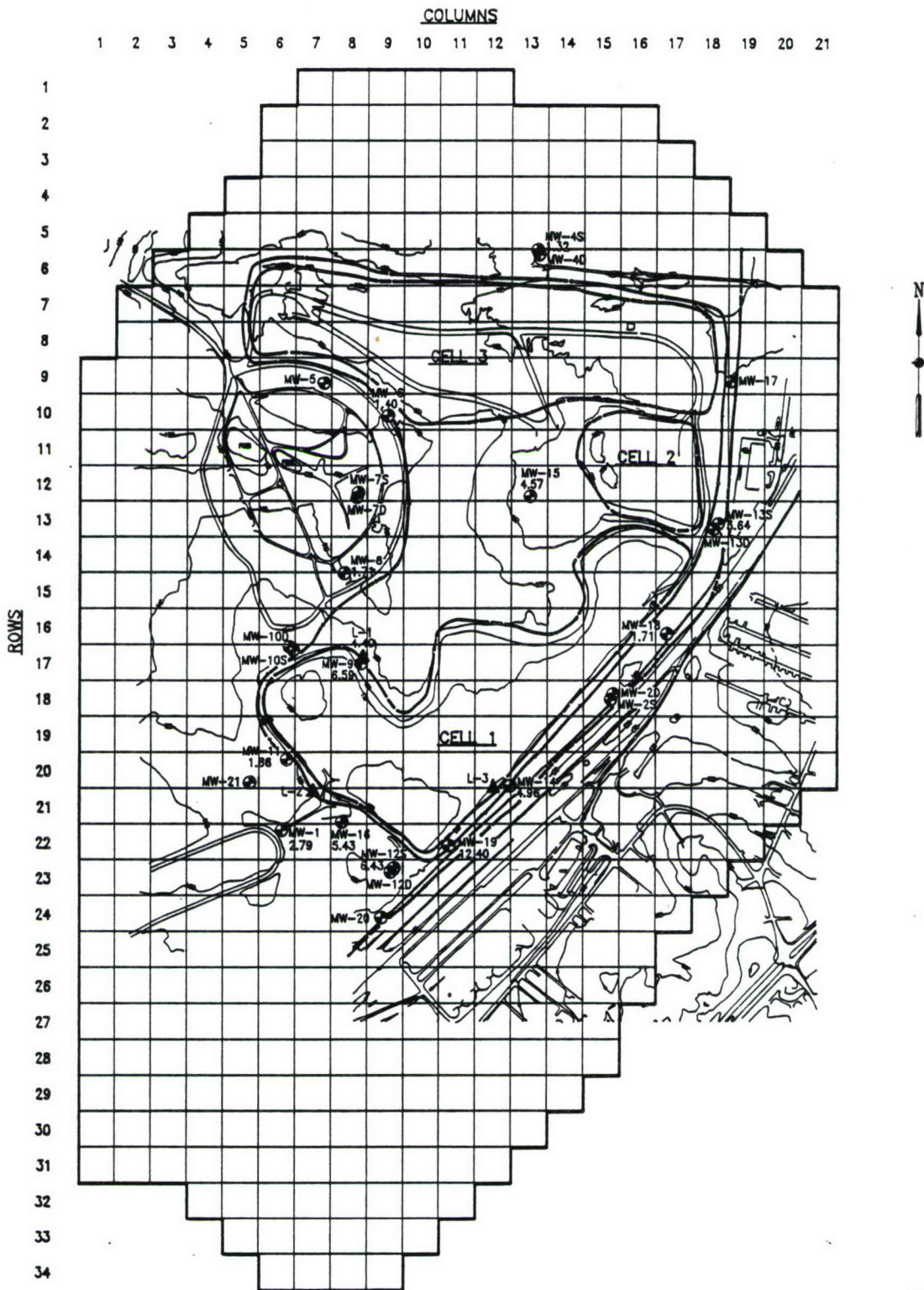
#### 2.4.4 Contaminant Migration Through the Middle Confining Layer

The travel time for the leachate-derived contaminants to penetrate the confining layer was calculated using Darcy's Law and assuming an effective porosity of 0.5 for the confining unit. The average permeability of the five Shelby tube samples collected from the confining unit (Table 2.2-3) during the installation of the monitoring wells in the confined (lower Patapsco) aquifer was  $8.4 \times 10^{-8}$  cm/sec ( $2.38 \times 10^{-4}$  ft/day). The ground water contour maps for the water-table and the confined aquifers (Figures 2.3-3 and 2.2-4) indicate that the hydraulic head difference between the water-table and the confined aquifer varies from approximately 30 ft in the vicinity of the streams along the western landfill boundary to 50-60 ft to the east and underneath most of the landfill. The confining layer is typically 50 ft thick across the site. Using both a 50-ft head difference and aquifer thickness results in a hydraulic gradient of 1 ft/ft. This scenario results in a velocity of 0.17 ft/year and a required travel time of 294 years to penetrate through the confining layer to the lower Patapsco aquifer. Allowing for a factor of two variation in the hydraulic gradient and/or permeability still results in a



time scale greater than 100 years, which is substantially longer than the approximately 30 years during which the landfill has been in existence. The 0.17 ft/year velocity is equivalent to a 1 in./year leakage rate from the upper to lower Patapsco aquifer. Thus, leakage is small compared to the 6 and 8 in./year recharge rates used in the ground-water model for the water-table aquifer.

Capping of the landfill within the next few years will eliminate infiltration over the landfill area. This will reduce the head that drives contaminant migration and work toward mitigating offsite transport.



FILE: CELLGRID



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REMEDIAL INVESTIGATION**  
FORT MEADE, MARYLAND

**ACTIVE SANITARY LANDFILL  
GROUND-WATER  
MODELING GRID**

PROJECT MGR  
**SAB**

DESIGNED BY  
**JCY**

DRAWN BY  
**MSM**

CHECKED BY  
**KWK**

SCALE  
**1"=900'**

DATE  
**10-3-91**

PROJECT NO.  
**10559.05**

FIGURE  
**2.4-1**



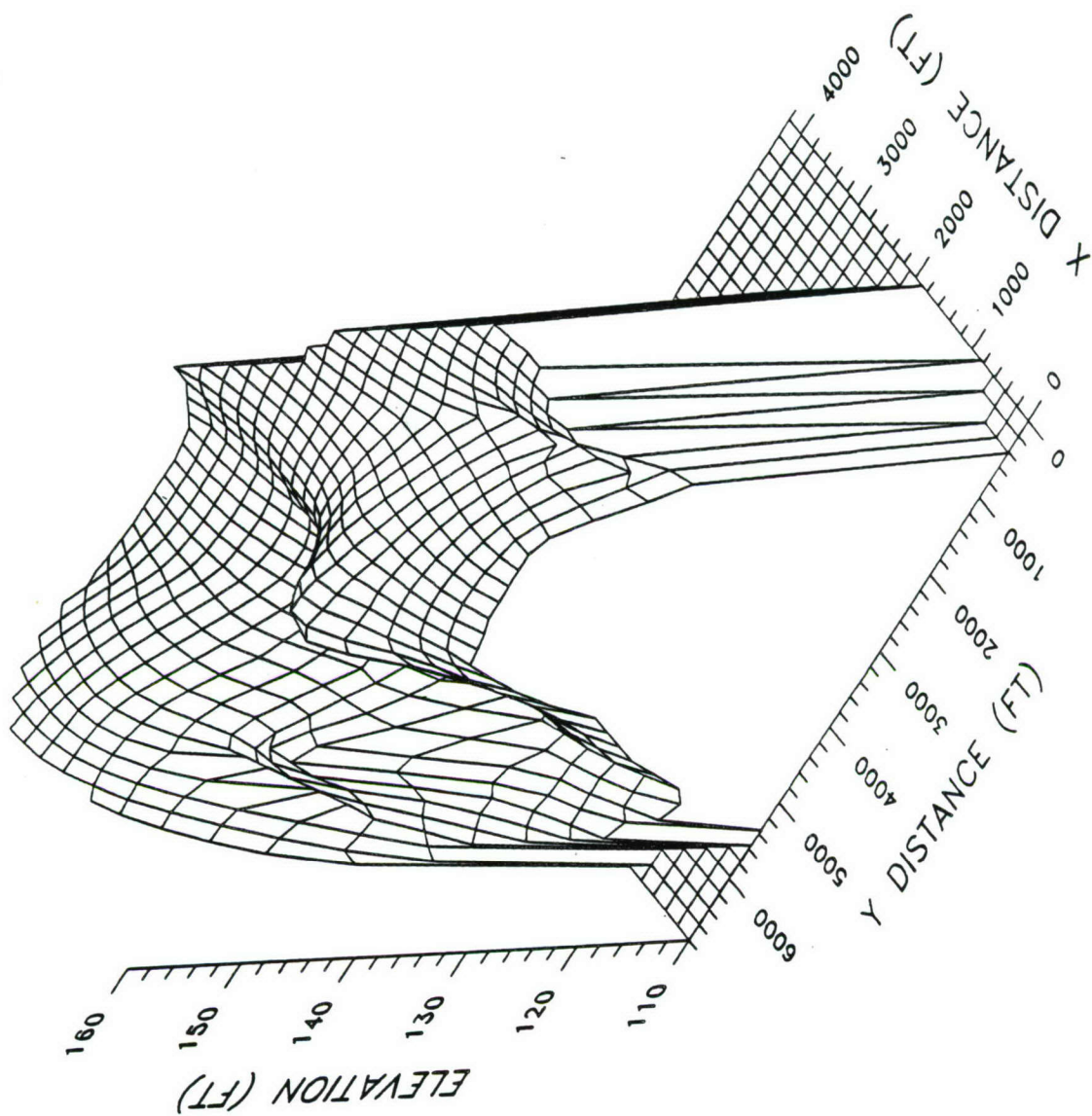
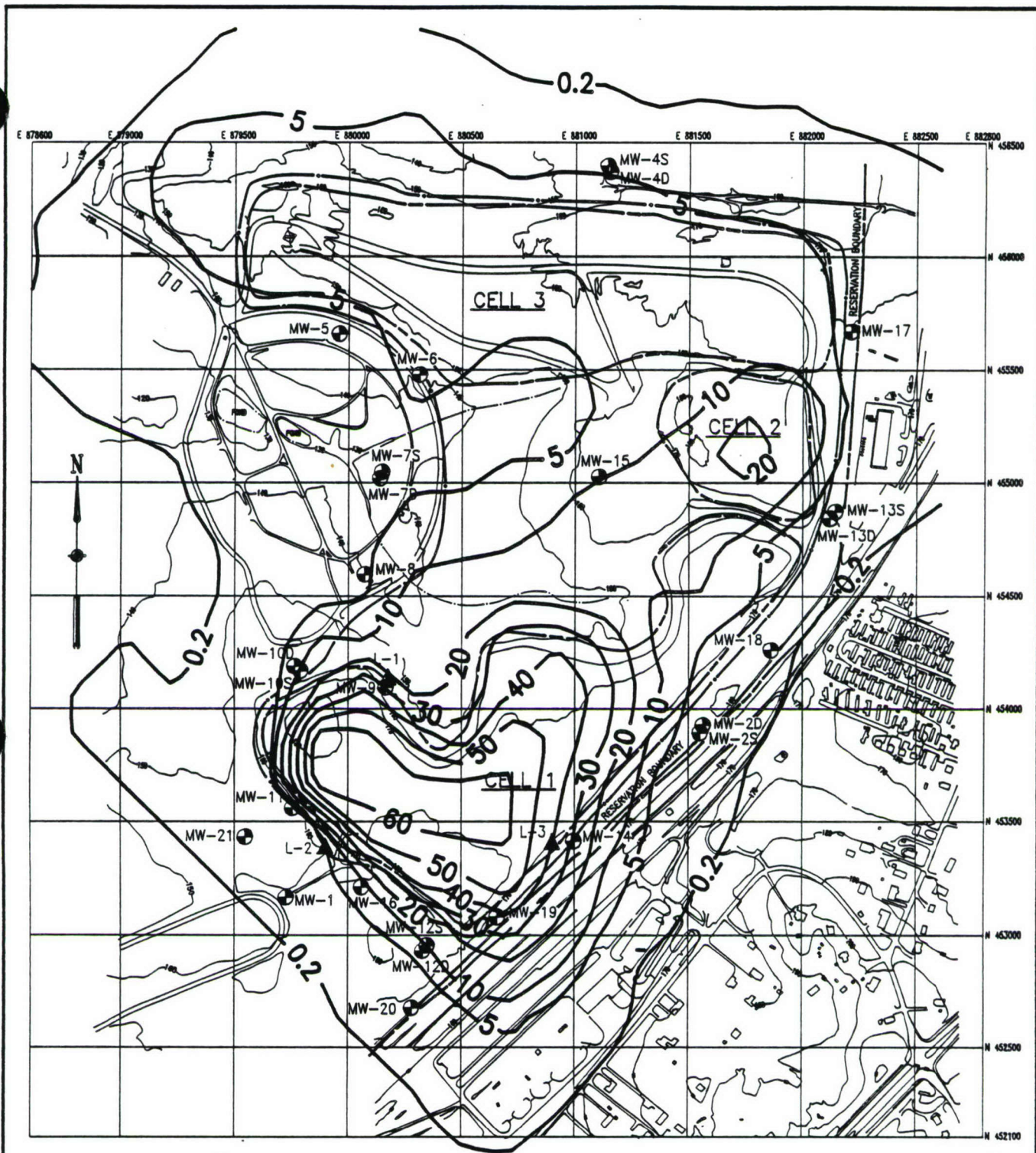


Figure 2.4-2. Predicted ground-water elevations at the Fort Meade Sanitary Landfill, 1990.



FILE: PBCHL00



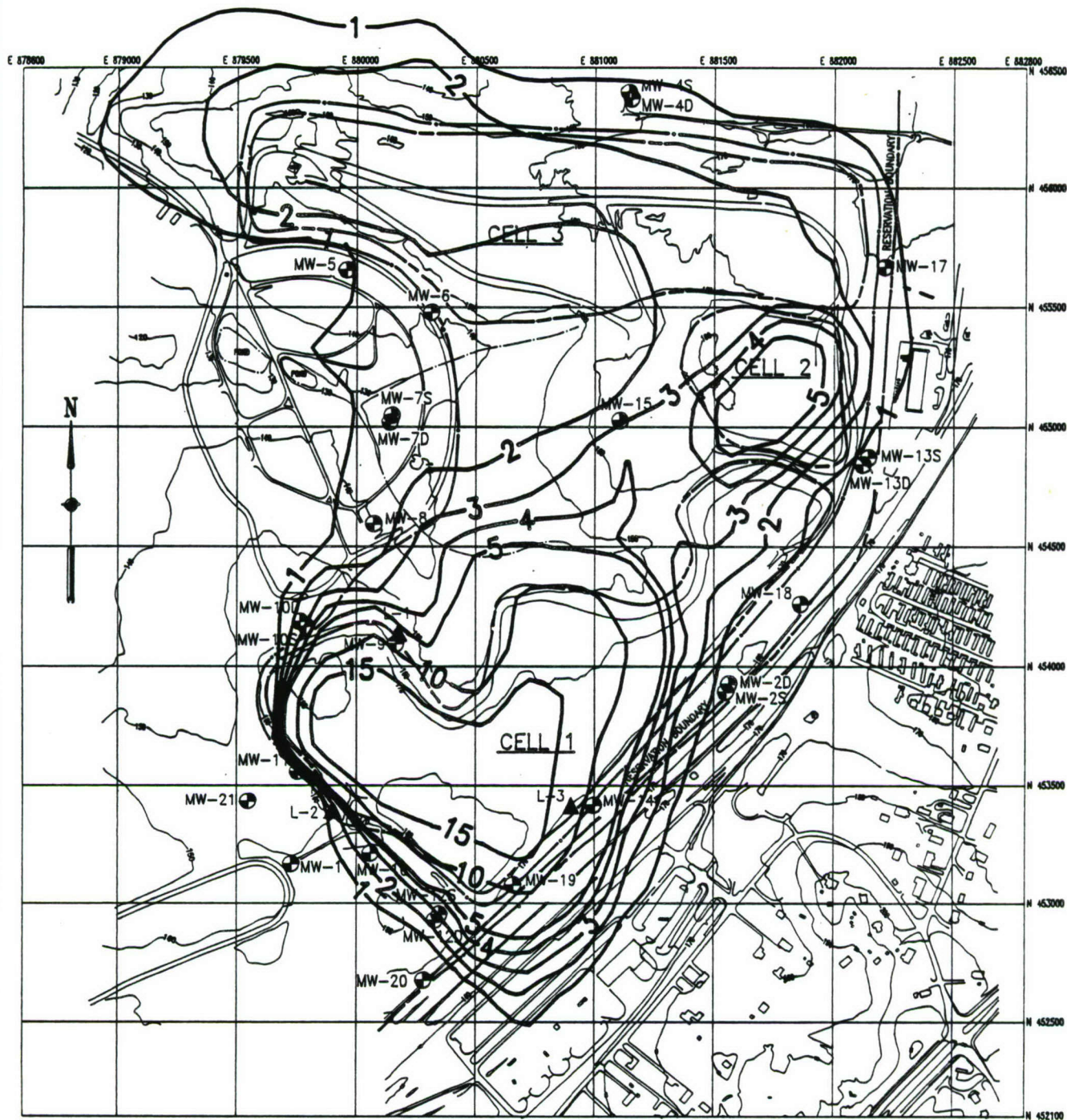
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FORT MEADE, MARYLAND

**ACTIVE SANITARY LANDFILL  
PREDICTED GROUND-WATER  
CONCENTRATION  
100 UNIT SOURCE, 1990**

PROJECT MGR	DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	DATE	PROJECT NO.	FIGURE
SAB	JCY	MSM	KWK	1"=650'	10-16-91	10559.05	2.4-3





FILE: PBC90



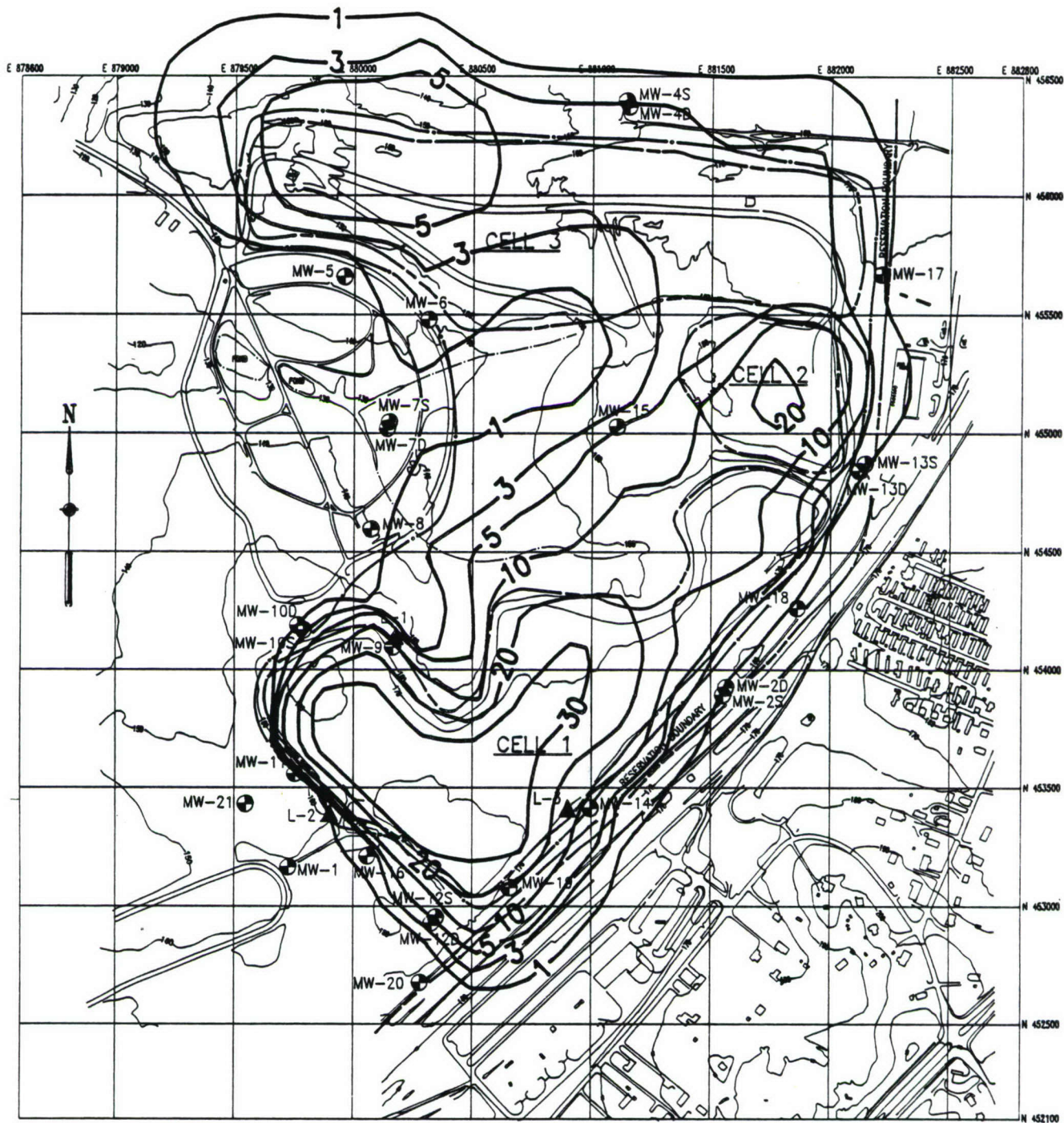
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FORT MEADE, MARYLAND

**ACTIVE SANITARY LANDFILL  
PREDICTED BENZENE  
CONCENTRATION  
1990**

PROJECT MGR SAB	DESIGNED BY JCY	DRAWN BY MSM	CHECKED BY KWK	SCALE 1"=650'	DATE 10-16-91	PROJECT NO. 10559.05	FIGURE 2.4-4
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FILE: PBCHL90

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FORT MEADE, MARYLAND

ACTIVE SANITARY LANDFILL  
PREDICTED BENZENE  
CONCENTRATION  
2 YEAR HALF-LIFE, 1990

PROJECT MGR	DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	DATE	PROJECT NO.	FIGURE
SAB	JCY	MSM	KWK	1"=650'	10-16-91	10559.05	2.4-5



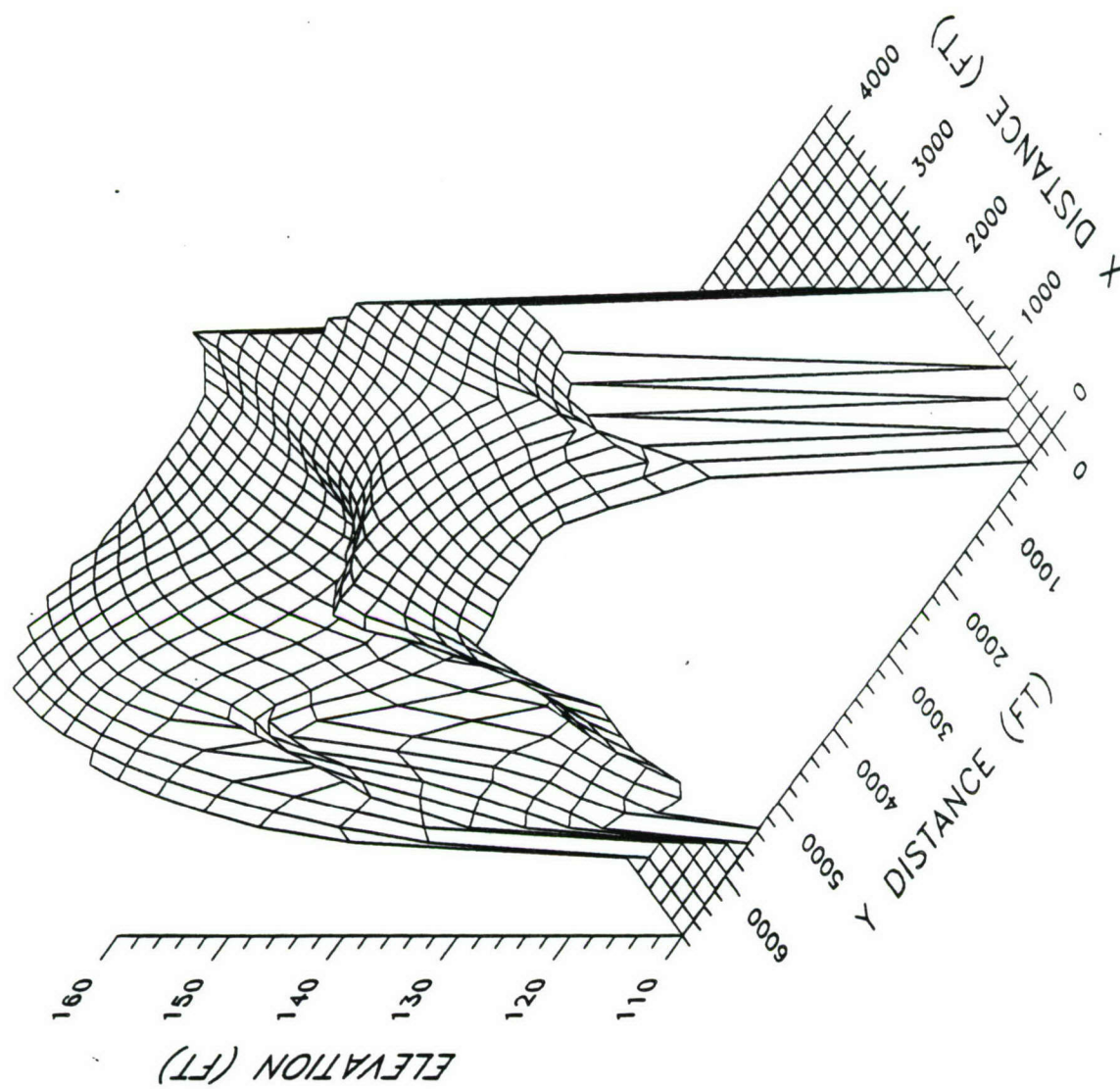
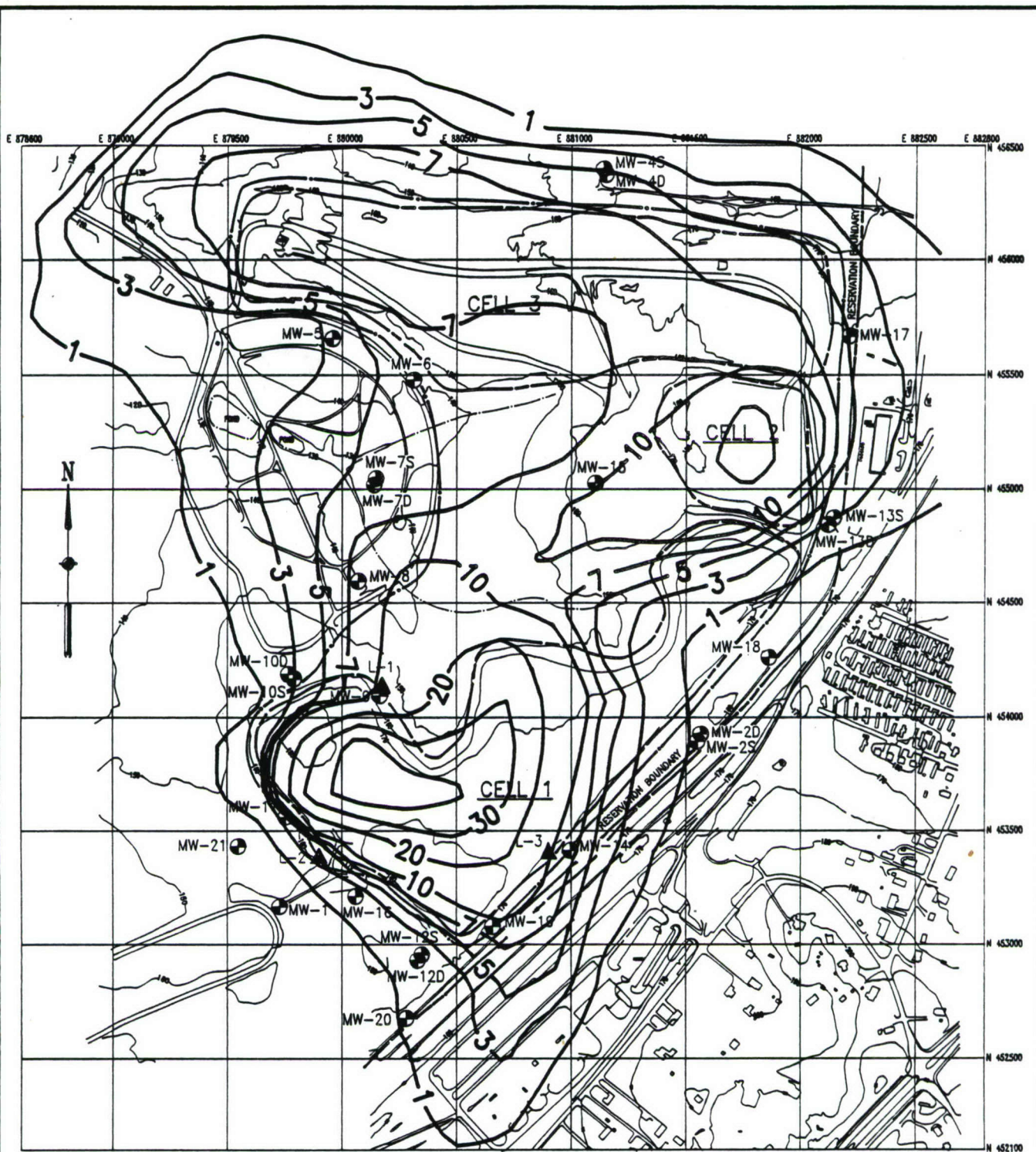


Figure 2.4-6. Predicted ground-water elevations at the Fort Meade Sanitary Landfill with Cell 1 cap, 2010.





FILE: PGWC10

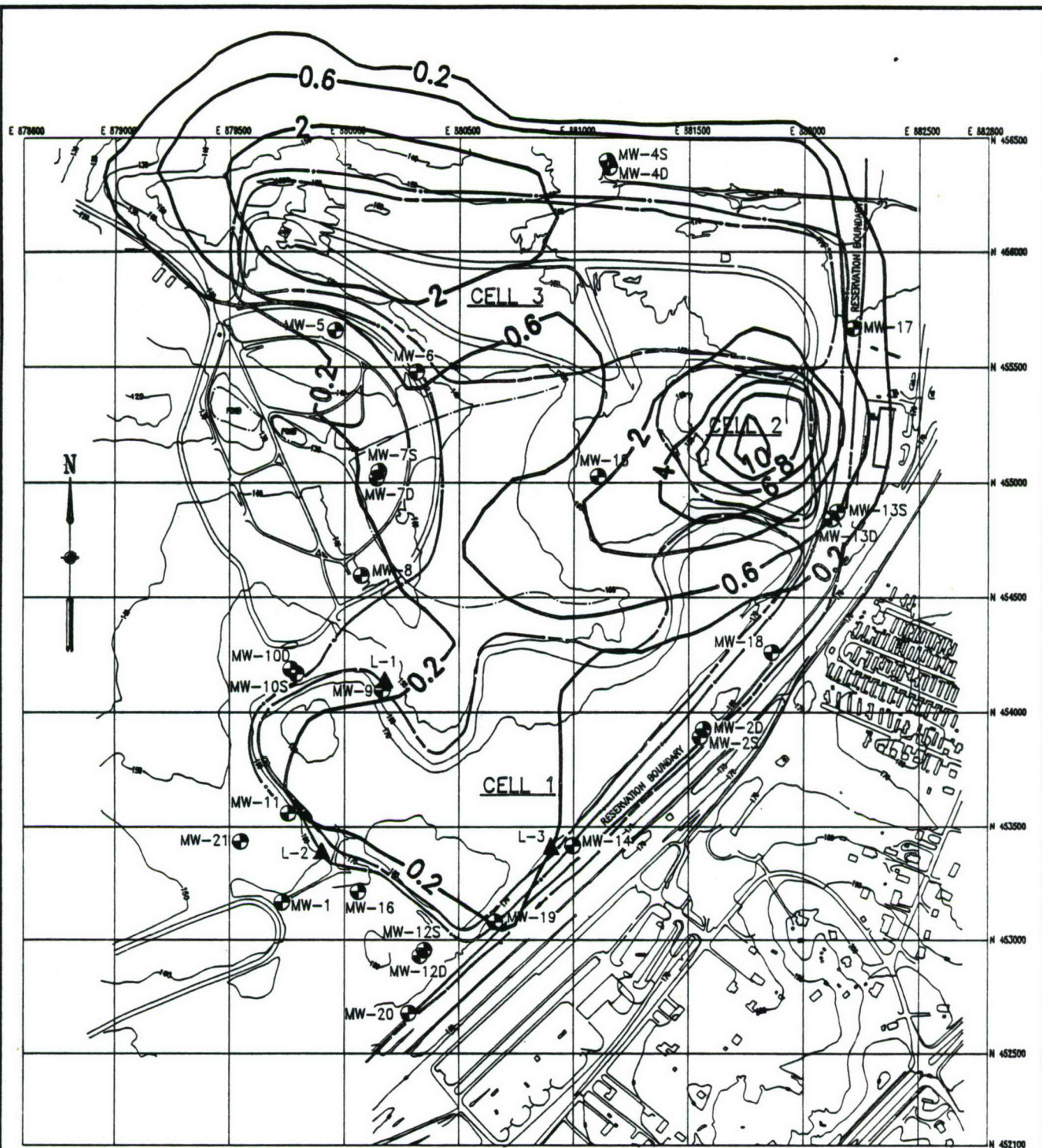
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ACTIVE SANITARY LANDFILL  
PREDICTED GROUND-WATER  
CONCENTRATION  
2010

PROJECT MGR	DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	DATE	PROJECT NO.	FIGURE
SAB	JCY	MSM	KWK	1"=650'	10-16-91	10559.05	2.4-7





FILE: PGWCHL00

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FORT MEADE, MARYLAND

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PREDICTED BENZENE  
CONCENTRATION  
2 YEAR HALF-LIFE, 2000

PROJECT MGR SAB	DESIGNED BY JCY	DRAWN BY MSM	CHECKED BY KWK	SCALE 1"=650'	DATE 10-16-91	PROJECT NO. 10559.05	FIGURE 2.4-8
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TABLE 2.4-1 CELL NODE IDENTIFICATION MATRIX FOR THE WATER-TABLE AQUIFER AT THE SANITARY LANDFILL

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1						1														
2						1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3						1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
4					1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	
5				1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
6					0	5	5	5	5	5	5	5	5	5	5	5	5	5	0	0	
7					0	5	5	5	5	5	5	5	5	5	5	5	5	5	0	0	
8					0	5	5	5	5	5	5	5	5	5	5	5	5	5	0	0	1
9					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10					0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1
11				1	1	1	0	0	0	1	0	0	0	0	4	4	3	0	0	0	1
12				0	0	1	1	1	0	0	0	0	0	0	4	4	3	0	0	0	1
13				0	0	0	0	1	0	0	0	0	0	0	4	4	4	0	0	0	1
14				0	0	0	0	0	1	0	0	0	0	0	4	4	3	0	0	0	1
15				0	0	0	0	0	0	1	1	1	0	0	4	3	3	0	0	0	1
16				0	0	0	0	0	0	0	0	0	0	0	4	3	0	0	0	0	1
17				0	0	0	0	0	0	0	0	0	0	0	4	3	0	0	0	0	1
18				0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	0	0	1
19				0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	0	0	1
20				0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	0	0	1
21				0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	0	0	1
22				0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	0	0	1
23				0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	0	0	1
24				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
25				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
26				0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
27				0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
28				0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
29				0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
30				1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
31				1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
32				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
33				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
34				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Note: Node 1 = Constant Head Boundary  
Node 2 = Vicinity of cell 1 with lifts  
Node 3 = Vicinity of cell 2 with lifts  
Node 4 = Vicinity of cell 2 with only trench fill activity  
Node 5 = Vicinity of cell 3 with only trench fill activity



TABLE 2.4-2

OBSERVED AND PREDICTED WATER-LEVEL ELEVATIONS IN THE  
MONITORING WELLS AT THE SANITARY LANDFILL

<u>Well</u>	<u>Elevation (ft)</u>		<u>Predicted - Observed</u>	<u>Column</u>	<u>Row</u>
	<u>Observed</u>	<u>Predicted</u>			
1	152.6	152.3	-0.3	6	22
2	147.3	146.7	-0.6	15	18
4	153.7	153.0	-0.7	13	6
5	144.7	144.9	0.2	7	9
6	139.1	140.8	1.7	9	10
7	135.1	135.0	-0.1	8	12
8	134.9	136.0	1.1	8	15
9	152.4	151.8	-0.6	8	17
10	156.2	153.2	-3.0	6	17
11	154.2	153.7	-0.5	6	20
12	152.6	151.4	-1.2	9	23
13	145.1	146.2	1.1	18	13
14	148.6	149.2	0.6	12	20
15	151.0	143.8	-7.2	13	12
16	152.0	153.2	1.2	8	21
17	147.2	147.8	0.6	19	9
18	144.3	145.9	1.6	17	16
19	149.8	149.9	0.1	11	22
20	150.5	150.4	-0.1	9	24
21	151.5	151.9	0.4	5	20

Observed: Average observed well elevation during the October 1989 -  
February 1991 study period.





TABLE 2.4-4 MULTIPLIER APPLIED TO SITE AVERAGE HYDRAULIC CONDUCTIVITY AT THE SANITARY LANDFILL

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Hydraulic Conductivity Multiplier at Column																				
1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
12	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
13	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
14	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
15	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
16	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
17	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
18	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
19	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
25	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
26	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
27	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
28	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
29	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
30	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
31	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
32	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
33	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
34	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Note: Multiplier applied to site average hydraulic conductivity of 6.2x10<sup>-5</sup> ft/sec.

TABLE 2.4-5 RECHARGE TO THE WATER-TABLE AQUIFER AT THE SANITARY LANDFILL

[illegible]



**TABLE 2.4-6 PREDICTED GROUND-WATER ELEVATIONS IN THE WATER-TABLE AQUIFER AT THE SANITARY LANDFILL**

[illegible]

TABLE 2.4-7 PREDICTED GROUND-WATER CONCENTRATIONS IN THE WATER-TABLE AQUIFER AT THE SANITARY LANDFILL, NO DECAY, 1976

[illegible]



TABLE 2.4-8 PREDICTED GROUND-WATER CONCENTRATIONS IN THE WATER-TABLE AQUIFER AT THE SANITARY LANDFILL, NO DECAY, 1990

[illegible]

**TABLE 2.4-9** **PREDICTED BENZENE CONCENTRATIONS IN THE WATER-TABLE AQUIFER AT THE SANITARY LANDFILL, NO DECAY, 1990**

[illegible]



**TABLE 2.4-10 PREDICTED BENZENE CONCENTRATIONS IN THE WATER-TABLE AQUIFER AT THE SANITARY LANDFILL, 2 YEAR HALF-LIFE, 1990**

[illegible]





**TABLE 2.4-12 PREDICTED GROUND-WATER CONCENTRATIONS IN THE SURFACE AQUIFER AT THE FORT MEADE SITE, NO DECAY, 2010**

[illegible]

**TABLE 2.4-13 PREDICTED BENZENE CONCENTRATIONS IN THE WATER-TABLE AQUIFER AT THE SANITARY LANDFILL, 2 YEAR HALF-LIFE, 2000**

[illegible]



## 2.5 BASELINE HUMAN HEALTH RISK ASSESSMENT FOR THE ACTIVE SANITARY LANDFILL

### 2.5.1 Introduction

This baseline risk assessment evaluated the ASL site. The ASL is a parcel of approximately 130 acres located in the southeastern region of Fort Meade. The overall objective of this assessment was to evaluate potential effects on human health and the environment posed by exposure to releases from the ASL. The assessment considered the possibility of releases to the ground water, surface water, sediment, and air.

#### 2.5.1.1 Site Background for Risk Assessment

The ASL has been used as a primary disposal site for solid waste since 1958. The Enhanced Preliminary Assessment Report referenced three sources (Bonds 1982; U.S. Army Medical Lab 1973; AEHA 1984) that indicated the possible disposal of hazardous materials at the landfill during its years of operation. The Preliminary Assessment indicated that there was potential for migration of contaminants via either surface water or ground water.

The ASL is bordered to the north by Baltimore & Ohio railroad tracks with a cemetery beyond, to the east by Amtrak railroad tracks and beyond that a trailer park, to the south by the Phelps Cemetery, and to the west by a former ammunition supply point with the weapons range control center beyond. The east boundary of the landfill along the Amtrak tracks is the eastern boundary of the FGGM property.

Prior to 1976 the disposal operations at the ASL were handled by the trench-fill method. Use of this method, however, led to rapid use of available open land. Therefore, in 1976, the area-fill method was adopted, increasing the life expectancy of the sanitary landfill by as much as 25 years. Currently the ASL is divided into three cells. Since 1976 two 10-ft lifts of waste have been placed over the trench-fill area in Cell 1. Cell 2 is the active fill area with two 10-ft lifts having been placed on a small portion at the eastern end of the cell. In Cell 3, no additional lifts have been placed above the trench-fill materials. In addition to municipal and domestic waste, petroleum waste products and pesticides reportedly were deposited at the site. Also in the northern portion of this landfill, digested sewage sludge was mixed with leaves and soil within a diked area to form compost for use in park and recreation areas.

The landfill does not have a liner or leachate-collection system. A seepage problem has been reported on the south and west sides of the landfill. The Enhanced Preliminary Assessment Report described extreme adverse conditions

which no longer exist. The report stated that the south-side seepage was black and green with thick black scum along the surface of the active landfill. At the time of the preliminary assessment, vegetation in the area had noticeably died along the treeline and was under stress further back into the woods. The seepage on the west side was described as yellow and red, also with a thick black scum along the surface (Argonne 1989).

Potable water supply wells for FGGM are located approximately 1,500 to 5,000 ft west (upgradient) of the landfill. Two water supply wells were installed in 1968, one of which is still used. Four wells were installed in 1983, of which three are still active. All of these wells are from 500 to 700 ft deep. The wells are capable of drawing at different levels within the confined lower Patapsco or Patuxent Formation. Normally, surface water provides 75 percent of FGGM's raw water needs, but for approximately 45 days in the year, 100 percent of the required water must be supplied by these wells.

#### 2.5.1.2 Human Health Evaluation

The assessment of human health risks for this site considered the following topics: (1) contaminants detected in ground water, surface water, sediment, and passive gas samples collected at the site; (2) potential environmental pathways by which populations might be exposed to compounds released from the site; (3) estimated exposure point concentrations; (4) estimated intake levels of the compounds of concern; (5) toxicity values of the compounds of concern; (6) current and future land-use conditions; and (7) uncertainties in the exposure and toxicity assessments. The level of risk that the site posed to human health was then quantified and discussed.

Separate risks were quantified for the water-table aquifer (using ground-water data from shallow monitoring wells completed in the upper Patapsco aquifer) and for the confined aquifer (using ground-water data from deep wells completed in the lower Patapsco or Patuxent aquifer).

#### 2.5.2 Identification of Chemicals of Potential Concern

In order to identify contaminants at the site, detailed chemical analyses of surface water, sediment, ground water, leachate, and passive gas samples were obtained. The data collection procedures followed in this process were described in Section 2.3 of this report. The sample data used in this risk assessment consisted of ground-water data collected in March 1991 from 20 shallow monitoring wells completed in the upper Patapsco aquifer and 6 deep monitoring wells completed in the lower Patapsco. Other data, including



surface water, sediment, leachate, and passive gas data, were considered qualitatively.

Environmental samples were collected in the field by EA and sent to EA Laboratories and DataChem Laboratories for analysis in accordance with the USATHAMA Quality Assurance Program. Analytical data were submitted to the Installation Restoration Data Management Information System (IRDMIS) where they were retrieved by EA for use in this risk assessment once they became Level 3 data.

The nature and extent of contamination in the ground water and surface water on or surrounding the site was suspected to occur primarily due to releases from the waste materials deposited at the landfill sites. Chemicals of potential concern in the ground water, surface water, and stream sediment were identified according to the following data management conventions.

Chemicals of potential concern are defined as chemicals detected during sample analysis and considered likely to have originated from site-related activities. Since the number of compounds detected at the site in any one medium was low, all compounds were considered for inclusion in the human health evaluation. Some metals, although found at the site, were eliminated from further consideration because they are essential human nutrients, are present in relatively low concentrations, and are toxic only at doses much higher than those associated with exposure at the site. These metals include calcium, iron, magnesium, potassium, and sodium.

Other compounds found in ground water were eliminated from further consideration either because they were also found in background samples from an upgradient well or because they were detected in trip or field blanks. These deletions are discussed in media-specific sections below.

The following general guidelines were used in managing the analytical data for the chemicals identified as being of potential concern:

- Analytical chemical data were summarized for each compound in each environmental medium. The arithmetic mean for each compound in each environmental medium was used as the measure of the average concentration of that compound. The 95th percentile upper confidence limit on the mean was used as the measure of the reasonable maximum exposure (RME) concentration. This RME concentration was the highest concentration likely to be encountered at the site over the duration of the time evaluated in the risk assessment.

- In calculating the arithmetic mean and 95th percentile upper confidence limit, one-half the CRL was used as the numeric value for those samples in which a compound was not detected.

In addition to these general guidelines, sampling and data management issues specific to each environmental medium are discussed in the following sections.

#### 2.5.2.1 Surface Water and Sediment Data

During the remedial investigation, surface water and sediment samples were collected from six surface water/sediment sites (SW-2 through SW-7 and SS-2 through SS-7) in the vicinity of the ASL (Plate 1). Both surface water and sediment samples were analyzed for volatile and semivolatile organic compounds, total metals, pesticides, and PCBs. Surface water and stream sediment data are presented in Tables 2.3-3 through 2.3-7. Only those compounds detected during chemical analyses are listed in these tables.

There were no volatile or semivolatile organic compounds detected in surface water in the vicinity of the ASL. Few metals were detected in surface water and, in general, those detected were found in low concentrations. No pesticides or PCBs were detected in any of the surface water samples.

No volatile organic compounds were found in any of the sediment samples. Several semivolatile organic compounds were detected in one of the six sediment samples. Pesticides and metals were found across the samples. No PCBs were detected.

#### 2.5.2.2 Ground-Water Data

Ground-water data used in this risk assessment were collected in March 1991 from 20 shallow and 6 deep wells. Shallow wells included MW-1, MW-2S, and MW-4S through MW-21 and represent water sampled from the water-table (upper Patapsco) aquifer. (Shallow wells are designated by a number or a number followed by the letter "S." Deep wells are always designated by a number and the letter "D.") Deep wells include MW-2D, MW-4D, MW-7D, MW-10D, MW-12D, and MW-13D, and represent water sampled from the uppermost confined (lower Patapsco) aquifer. Data from the water-table aquifer and the confined aquifer were evaluated separately in the risk assessment.

The risk assessment used ground-water concentrations for total metals as opposed to dissolved metals. Ground-water data for compounds that were detected are presented in Tables 2.3-8 through 2.3-14. In these tables, volatile and semivolatile organic compounds, pesticides, and total and dissolved metals are listed because they were detected in at least one



of the samples in either the shallow or deep wells. No PCBs are listed because none were detected in ground water in either the shallow or deep wells.

#### Water-Table Aquifer Data

Ground-water data are summarized for all compounds detected in shallow ground water in the vicinity of the ASL in Table 2.5-1. Of the 20 monitoring wells completed in the water-table aquifer, one (MW-4S) was considered to be an upgradient or background well. Table 2.5-1 presents statistics for the other 19 shallow samples, including the number detected out of the 19, the minimum and maximum of those values which were detected, the mean of all 19 samples including the nondetected values at one-half the CRL, and the 95th percentile upper confidence limit on the mean. The concentrations found in the background well are also listed.

Volatile organic compounds detected in the samples collected from the shallow or water-table aquifer include benzene, chlorobenzene, chloroform, 1,1-dichloroethane, 1,2-dichloroethene, 1,2-dichloropropane, ethylbenzene, tetrachloroethene, toluene, trichloroethene, and xylenes. For the purposes of this risk assessment, chloroform, 1,2-dichloropropane, and tetrachloroethene were not considered further. Each of these chemicals was detected once in the 19 samples analyzed, each being present in a separate sample, and they were also detected within the respective field blank. In accordance with accepted guidance (U.S.EPA 1989), the presence of these compounds at levels less than five times the level observed in the field blank, and their individual occurrence in only one of the 19 samples, was the basis for their exclusion.

Semivolatile organic compounds detected in the shallow wells include p-chloro-m-cresol, 1,2-dichlorobenzene, 1,4-dichlorobenzene, diethyl phthalate, 2,4-dimethylphenol, and naphthalene. All semivolatile compounds were retained in the risk assessment.

The following metals were detected in at least one shallow monitoring well: aluminum, arsenic, barium, beryllium, chromium, cobalt, copper, lead, manganese, nickel, selenium, silver, vanadium, and zinc. The naturally occurring metals or inorganic compounds, such as calcium, iron, magnesium, potassium, and sodium, were detected but not considered further in this risk assessment. The elimination of these compounds followed EPA risk assessment guidance and was based on their qualification as essential human nutrients. In addition, aluminum, lead, and zinc were present at levels below those observed in the background sample, and they were also not considered further.

The pesticides aldrin, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC (lindane), 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, endosulfan I and II, endrin, heptachlor, heptachlor epoxide, isodrin, and methoxychlor were also found in various combinations in 16 of the 20 shallow ground-water samples from near the ASL. All pesticides were retained.

#### Confined Aquifer Data

Compounds detected in the confined, lower Patapsco aquifer in the vicinity of the ASL are summarized in Table 2.5-2. No volatile organic compounds were detected in the deep wells. Compounds detected included one semivolatile organic compound [bis(2-ethylhexyl)phthalate] and eight pesticides (aldrin, alpha-BHC, delta-BHC, 4,4'-DDT, dieldrin, heptachlor, isodrin, and methoxychlor). The semivolatile compound and the pesticides were retained for further consideration in the risk assessment.

Several metals, including aluminum, barium, beryllium, cobalt, manganese, nickel, selenium, silver, and zinc, were detected in one or more deep ground-water samples. The naturally occurring metals or inorganic compounds (calcium, iron, magnesium, potassium, and sodium) were not considered further within this risk assessment on the basis of their qualifying as essential nutrients. In addition, aluminum, barium, selenium, silver, and zinc were eliminated from consideration because the average concentration in the deep well samples was at or below the concentration observed in the background well (MW-4D).

#### 2.5.2.3 Other Ground-Water Data

One other category of ground-water samples was collected in the vicinity of the ASL, namely three leachate samples. These data are listed in Tables 2.3-15 and 2.3-16. The three leachate samples contained five volatile and seven semivolatile organic compounds, 11 pesticides, and 19 metals including the five essential nutrients.

#### 2.5.2.4 Passive Gas Data

Twelve passive gas samples were taken over the area of the ASL with a concentration of the samples in Cell 1. The purpose of these samples was to assess the potential for toxic air emissions from the landfill. These samples are described in Section 2.3.7, and the data are presented in Table 2.3-19. It should be noted that concentrations measured as passive gas samples are in-ground concentrations. Concentrations immediately over the landfill do not reach these levels, and if any gas is emitted from the landfill, these concentrations are quickly diluted by dispersion. Given the low levels of



compounds observed in the passive gas samples, the generation of landfill gas is not considered to be a public health concern, and the air pathway is not quantitatively assessed in the risk assessment.

#### 2.5.2.5 Summary of Chemicals of Potential Concern

Tables 2.5-1 and 2.5-2 list average (mean) and RME (95th percentile upper confidence limit on the mean) concentrations for all chemicals detected in either the water table or confined Patapsco aquifers in the vicinity of the ASL. All compounds were screened with respect to the concentrations found in several types of blank samples. In addition, metals were screened by comparison with background levels or their properties as essential human nutrients.

In the water-table aquifer, eight of the eleven detected volatile organic compounds were retained in the risk assessment. Three compounds (chloroform, 1,2-dichloropropane, and tetrachloroethene) were present in low concentrations in one sample each, were present in the field blank, and were eliminated at this point. All six semivolatile organic compounds and the 16 pesticides listed in Table 2.5-1 were retained for consideration in the risk assessment. Of the 19 metals detected, the five essential nutrients plus aluminum, lead, and zinc were not considered further. The latter three metals were eliminated because they were detected in downgradient wells at concentrations similar to those observed in the upgradient (background) well.

No volatile organic compounds were detected in the confined aquifer, and hence none were carried through the risk assessment process. The single semivolatile organic compound and the eight detected pesticides were included in the risk assessment. Of the fourteen metals detected in the deep wells, five were eliminated because they are essential nutrients and five because they were reported at concentrations similar to background concentrations. The four metals that were included in the risk assessment for the confined aquifer were beryllium, cobalt, manganese, and nickel.

The remaining compounds were considered to be compounds of potential concern and were carried through the risk analysis to quantify the potential risk posed to humans by releases from the site. In each aquifer, the average concentrations and the upper 95th percentile confidence limits on the mean were used for two separate estimates of risk, i.e., average risk and RME risk.

#### 2.5.3 Exposure Assessment

This section addresses the potential pathways by which human populations, under present and future land use conditions, may be exposed to chemicals of

potential concern in the various media onsite or through media associated with the site.

As discussed in U.S. EPA (1989) guidance, an exposure pathway generally consists of the following four elements:

- A source and mechanism of chemical release,
- A retention or transport medium (or media in cases involving media transfer of chemicals),
- A point of potential human contact with the contaminated medium (i.e. the exposure point), and
- An exposure route at the contact or exposure point.

An exposure pathway is considered complete only if each of these elements are present. The landfill serves as the source, while ground water, leachate, surface water, sediment, and air comprise the transport media. The third and fourth components, the exposure point, and the exposure route are discussed below. Potential exposures of humans to contamination on and adjacent to the site under current and future conditions were evaluated, and the routes through which individuals may be exposed are discussed.

#### 2.5.3.1 Exposures Under Current Land Use Conditions

Currently, the ASL site exists as an uncapped, unlined, active sanitary landfill. Aside from occupational exposure, recreational hunting is permitted in the area. Possible exposure pathways were considered for each of the types of media samples collected in the field assessment of this site. Exposure pathways considered for this assessment are summarized in Table 2.5-3.

##### Ground-Water Samples

A risk assessment under current land use conditions was performed using the ground-water data collected at the ASL. Under current land use the ground water from this area is not used for drinking water by onsite residents. However, there is a limited potential for ingestion of ground water by residents living adjacent to the southeast boundary of the base. Hydrogeologic patterns of modeled ground-water flow suggest that ground water follows a southeasterly gradient placing certain residential wells in this area potentially within the ground-water flow contours. While ground water appears to flow in this direction, it has not actually been ascertained that this ground water serves as a drinking water source for area residents. The



exposures resulting from potential drinking of ground water from both the shallow water-table aquifer and the deeper confined aquifer have been estimated.

Leachate samples from the ASL were collected, but no risk assessment was done using these data because no one consumes this water.

#### Surface-Water and Sediment Samples

Five surface water and five sediment samples were collected near the ASL from the small streams emanating from the western boundary of the fill area. One surface water and one sediment sample were also collected from an area of standing water along the eastern boundary of the ASL. These areas may be used infrequently by adults for recreational activities such as hunting. Under these circumstances exposure could occur in several ways, for example, through dermal exposure or incidental ingestion. Though both routes are possible, neither is considered likely. Even if exposure of this nature were to occur, chemical intake would be minimal because exposure would be infrequent. The only compounds detected in surface water were metals. In sediment, there were no volatile organic compounds, and semivolatile compounds were detected in only one sample. Metals and pesticides were detected across sediment samples but in generally low concentrations. Therefore, these pathways were not assessed quantitatively in this risk assessment.

Individuals may be exposed indirectly to contaminants in surface water by eating fish that have bioaccumulated contaminants of concern from living in the water. This was not considered to be a pathway of concern at the ASL. Only metals were detected in surface water samples. Compounds in ground water would dilute before they reached surface water. Even if compounds did contaminate surface water in sufficient concentrations, it is highly unlikely that any one person would consume enough fish tissue from this source over a period of time extensive enough to result in a measurable risk.

#### Air

As hunters traverse the site, they may inhale either fugitive dust containing contaminants of concern or volatile contaminants emitted from the landfill. The site is grown over and well grassed. This decreases the potential for fugitive dust generation and, together with the subsurface nature of the contamination, results in little concern for this exposure pathway. Passive and active gas samples showed that gas concentrations within the landfill were well below levels that might cause adverse health effects. Concentrations

in air above the landfill would be even more dilute. Because of the low concentrations together with the infrequent contact, this pathway was not considered further in the risk assessment.

#### 2.5.3.2 Exposure Under Future Land Use Conditions

The Army has transferred 7,600 acres of FGGM to the Fish and Wildlife Service as an extension of the Patuxent Wildlife Research Center. The Army has kept the area of the ASL and will continue to operate it as a landfill. Eventually, they will cap the ASL according to MDE regulations. Even after capping, use of the site will be restricted and it is not likely to be developed.

Exposure pathways considered under this future land use scenario are the same as those considered under the current land use conditions, and are summarized in Table 2.5-3. The assessment of risks under future land use conditions encompasses the following environmental media.

##### Ground-Water Samples

Under the future use scenario, ground water from the leachate samples is not likely to be consumed and, therefore, these data were not further used in this risk assessment.

Although the potential for drinking water wells to be installed onsite or directly adjacent to the site is highly unlikely, the ASL is close to the FGGM boundary and the future ingestion of ground water by nearby residents was evaluated. The risk due to this exposure pathway is analogous to the risk under current land use, because it represents the future risk in the absence of any remediation. However, the difference between the risks under current versus future land use conditions should be considered in light of any future remediation or closure activities, namely the capping of the landfill. It is expected that capping the ASL will decrease the infiltration of precipitation into waste, effectively reducing contaminant leaching processes within the landfill, and thereby reducing the effective ground-water contaminant concentrations. While this cannot be quantified, the expectation is that risks estimated under the future land use but based on current ground-water concentrations will provide overestimations of risk. This will be further discussed in additional sections.



### Surface-Water and Sediment Samples

In order for there to be an actual risk from contaminants in surface water or sediment, there has to be substantial exposure and high levels of contaminants in the surface water or sediment. Factors that contribute to minimize risk from these media include limited duration of exposure, as in an activity such as wading, limited opportunity for incidental ingestion, and reduction in effective concentration in the body via absorption through the skin, e.g., metals have very low absorption coefficients. Even in the unlikely event of heavy exposure such as long-term swimming, the risk resulting from these low levels of compounds would be minimal. Therefore, no quantification of risk was carried out for pathways involving surface water or sediment.

### Air

Because of the low concentrations of compounds in the gaseous state within the landfill and because the landfill will eventually be capped, no exposure pathways via inhalation of contaminants emitted from the landfill was undertaken.

#### 2.5.3.3 Estimation of Chemical Intakes

To quantitatively assess the potential risks to human health associated with the exposure scenarios considered in this assessment, the exposure point concentrations were converted to intakes. Intakes are expressed as the amount of a substance taken into the body per unit body weight per unit time. They are commonly expressed in units of mg/kg·day. An intake is averaged over a lifetime for carcinogens and over the exposure period for noncarcinogens.

Two levels of exposure were estimated for each exposure pathway that was quantified. This provided an estimate of the range of exposures expected to result from the site. First, average exposure was calculated using average exposure assumptions together with the average concentration occurring on the site. Then, RME exposure was calculated using higher, more intense exposure assumptions together with the 95th percentile upper confidence limit on the mean as the exposure concentration.

#### Current Potential Ingestion of Ground Water by Residents

Currently, ground water onsite is not used as a drinking water source; however, the potential for offsite use as a drinking source may exist along the southeastern boundary of FGGM. Although the presence of contaminants was not ascertained for offsite ground water, the direction of ground-water flow suggests that ground water from the vicinity of the ASL could serve as

a potential source for offsite human exposure. For this reason, daily intakes were estimated for ingestion of ground water from both the water-table aquifer and the confined aquifer using onsite data.

Exposure from ground-water ingestion was determined for both average and RME exposure scenarios. This was accomplished by calculating the average and RME intake of ground water using the following equation (Equation 2.5.1).

$$\text{Intake (mg/kg}\cdot\text{day)} = \frac{\text{CW} \times \text{CF} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}} \quad (\text{Equation 2.5-1})$$

where

CW = compound concentration in water ( $\mu\text{g/L}$ )  
CF = conversion factor ( $\text{mg}/\mu\text{g}$ )  
IR = ingestion rate of water ( $\text{L/day}$ )  
EF = exposure frequency ( $\text{days/year}$ )  
ED = exposure duration (years)  
BW = body weight (kg)  
AT = average time (days)

Potential ingestion of ground water is estimated for a person living adjacent to the southeastern boundary of the site and using the ground water from the site as their primary source of drinking water. Following EPA guidance, intake was estimated for adults weighing an average 70 kg and consuming 1.4 L (average case) to 2.0 L (RME) of contaminated water per day (U.S.EPA 1989).

Assumptions for average and reasonable maximum exposure scenarios are given in Table 2.5-4. Exposure frequency was assumed to be 345 days/year in the average case and 350 days/year for the RME; i.e., in the RME exposure, the person ingesting ground water consumed drinking water at home every day, except for two weeks of vacation. Exposure duration for the average case was assumed to be 9 years, the 50th percentile of the distribution of time spent in one residence (U.S.EPA 1989). In the RME, exposure duration was assumed to be 30 years, the 90th percentile of time spent in one residence (U.S.EPA 1989). Average time for exposure to carcinogens was 70 years for both average and RME cases. Average time for noncarcinogens was the same as exposure duration, 9 years for the average case and 30 years for the RME.

#### Future Potential Ingestion of Ground Water by Residents

While it seems unlikely that anyone will be drinking onsite ground water in the foreseeable future, the potential for offsite ground-water use as a drinking source might exist along the southeastern boundary of FGGM, as it might under the current land use scenario. The ASL will almost certainly be



capped, although the exact extent to which this procedure will reduce the potential for offsite ground-water contamination cannot be quantified at this time.

Intakes from the ingestion of ground water were estimated for hypothetical persons living on or off the site and using the ground water from the site as the primary source of their drinking water. As such, these intakes in the future will be the same as those estimated under the current land use conditions. While intakes may be reduced due to future landfill capping, this reduction can only be addressed qualitatively.

#### Current and/or Future Intakes via Ingestion of Ground Water

Average and RME assumptions in Table 2.5-4 were used together with concentrations given in Tables 2.5-1 and 2.5-2 to estimate daily intakes. Intakes for noncarcinogenic and carcinogenic effects from the chemicals of concern in the water-table aquifer are given in Table 2.5-5 and 2.5-6, respectively. The data obtained from the analysis of the samples collected from 19 wells completed in the water-table aquifer in the vicinity of the ASL provided the average and RME concentrations shown in the first two numeric columns in Tables 2.5-5 and 2.5-6. The last two columns of these tables give the average and RME intakes via ingestion of water-table aquifer ground water. Because average lifetime, a variable in the intake equation, is different for noncarcinogens and carcinogens, the intakes for the two types of effects are different. Fewer compounds are included in Table 2.5-6 because not all of the chemicals of concern are carcinogens.

Data from the five wells completed in the confined aquifer in the vicinity of the ASL were used to calculate noncarcinogenic and carcinogenic intakes via ingestion of this confined aquifer water. These intakes are shown in Tables 2.5-7 and 2.5-8, respectively.

#### 2.5.3.4 Uncertainties in the Exposure Assessment

As with any exposure assessment, there are uncertainties associated with the exposure scenarios used in the risk assessment. There are uncertainties associated with estimates of how often, if at all, an individual would come into contact with the chemicals of concern in various site media and the period of time over which such exposures would occur. For example, the period of time a person might use an onsite water source for drinking water cannot be known and was estimated. Uncertainty can lead to over- or under-estimation of risk. However, conservative assumptions were made throughout the exposure assessment, and it is likely that these conservative assumptions resulted in an overestimation of the risks calculated for the exposure scenarios.

In addition to uncertainties, there is a level of confidence that can be placed in the data collected and analyzed for the RI. In this exposure assessment, the RI sampling data were used for estimates of concentrations which were then used in the quantitative calculation of intakes. In other words, no concentrations used in the exposure assessment were derived by modeling, and therefore no uncertainties inherent in modeling were introduced. However, the data were obtained from only a single round of sampling, and as such represent the levels of compounds observed during only one sampling event. The lack of additional data introduces uncertainty with respect to the confidence in a solitary data set.

The greatest uncertainty in the ground-water exposure assessments is associated with the potential consumption of contaminated ground water both on- and off-site. Under the current land usage situation, there are no water supply wells onsite other than the public water supply wells, which are screened in the deeper aquifers. The majority of the offsite area southeast of the landfill along Patuxent Road is served by public water. Based on information from the Anne Arundel County Health Department, the six residences along Galloway Road use ground water as a drinking water source. Under future land use conditions (i.e., landfill capping), it is extremely unlikely that individual drinking water wells will be developed on the site. While the potential for offsite well installation may increase with distance from the site, the exposure point concentrations will decrease with distance from the site as well. If offsite use of ground water occurs along the southeast border of FGGM in the future, and if it is used for drinking water purposes, the exposure point concentrations offsite will not only have decreased with distance from the site, but will have been decreased because of the existence of the proposed landfill cap. No consideration was given to attenuation of concentration levels with distance from the site, with capping of the ASL, or with degradation over time. All of these factors serve to overestimate intakes and ultimately the risks.

Other uncertainties leading to a probable overestimation of risk are inherent in assumptions concerning exposure frequency and duration. The exposure assumption is that residents consume all their drinking water from onsite wells for 345 or 350 days of the year. Since it is reasonable that some water is consumed away from home (e.g., at work), this assumption overestimates the risk. When considering carcinogens, it was assumed that the exposure was for a lifetime, i.e., 70 years. This assumption also overestimates the risk since it is unlikely that any one person will reside on the site for an entire lifetime.



#### 2.5.4 Toxicity Assessment

This step in the risk assessment involved identifying relevant health risk values for the contaminants of concern. These health-risk values were used with the estimated intake values calculated from the exposure assessment to calculate the risk due to exposure.

In order to quantify noncarcinogenic risk, the chronic reference dose (RfD) in mg of compound per kg of body weight per day (mg/kg·day) is used. According to EPA documentation, the chronic RfD is defined as "an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime" (U.S. EPA 1989). These values were used to evaluate the potential noncarcinogenic effects associated with exposure periods of between 7 years and a lifetime. For purposes of this assessment, the oral RfD was used, because the primary concern is health risk associated with ground-water exposure through ingestion, i.e., drinking the ground water.

While noncarcinogens have a toxicity threshold below which they are not considered a health hazard, carcinogens are believed to pose a threat to human health at any level of exposure. Because there is no threshold for carcinogens, the associated risk is quantified differently than the risk for noncarcinogens. The risk value for carcinogens is the slope factor, which is measured in (mg/kg·day)<sup>-1</sup> and represents the upper 95th percentile confidence limit on the slope of the dose-response curve. The slope factor therefore represents the estimated upper-bound excess cancer risk associated with lifetime exposure to 1 mg/kg·day of a compound. There is a 95 percent chance that the actual risk value is lower than the risk predicted using the slope factor.

Slope factors and RfD information are available through an online computer database known as the Integrated Risk Information System (IRIS), which is maintained by the EPA (U.S.EPA 1992a). When such information was not available on IRIS, the EPA's Health Effects Assessment Summary Tables (HEAST FY 1992) (U.S. EPA 1992b) were consulted. HEAST contains some information not available on IRIS, including toxicity information presently under review by EPA work groups, which is therefore subject to change. The informational source hierarchy recommended by EPA is IRIS followed by HEAST. While the HEAST values do not always have the same level of review as IRIS values, they do provide the best estimates for the toxicity values available at the time, and they provide a basis for quantifying risk.

The toxicity information for compounds of concern in this risk assessment are listed in Tables 2.5-9 and 2.5-10. These tables include all available



toxicity values for all compounds of potential concern derived from those listed in Tables 2.5-1 and 2.5-2. Table 2.5-9 includes the RfDs for assessing noncarcinogenic risk and relevant information concerning these RfDs. Table 2.5-10 lists the slope factors used for quantifying carcinogenic risk. Other information given for carcinogens includes the weight of evidence classification and the cancer type. Only compounds with weight of evidence classifications of A, B1, B2, or C are included on this table.

In these toxicity value tables, "NA" indicates that a toxicity value is not available. If "NA" is given for an RfD, the compound is less likely to have toxic effects and may be omitted from an assessment of the noncarcinogenic risks. If NA is given for a carcinogenic compound with a weight of evidence classification of A, B1, B2, or C, the compound has some potential for carcinogenic effects, but a quantitative value has not or cannot be assigned to it.

Some toxicity values are listed as "ND," indicating toxicity values have not been determined. In these cases, there may or may not be adverse health effects, and toxicity values are either still being developed or simply have not been addressed. These compounds may add to the total risk, but without the toxicity values, risks cannot be quantified.

The status of toxicity values for all compounds of concern was verified on IRIS (December 1992) (USEPA 1992a) and HEAST (Annual FY 1992) (USEPA 1992b). Several compounds are currently listed on IRIS or HEAST as being "under review" with respect to their noncarcinogenic toxicity values (RfDs), in which case a chemical-specific interpretation of the applicability of the use of quantitative toxicity values was made. A brief discussion of toxicity values which require qualifying statements with respect to their use in this risk assessment follows.

Compounds which are currently under review on IRIS, yet have chronic HEAST values, include: vanadium, 1,1-dichloroethane, and naphthalene. HEAST values were used for these compounds. The chemical p-chloro-m-cresol is also under review on IRIS, yet has a sub-chronic HEAST value (2E+0 mg/kg/day). Since the sub-chronic HEAST value was based upon a sub-chronic study, a chronic value was derived (2E-01 mg/kg/day) by adjustment with an additional uncertainty factor of 10, an accepted methodology (USEPA 1989). There were 2 compounds, arsenic and endosulfan I, which are currently under review on IRIS, and list HEAST sub-chronic toxicity values equal to the chronic IRIS values for these chemicals. The arsenic oral RfD is actually listed on IRIS, with the qualifying comment that there is still no clear consensus among the reviewers. In lieu of omitting these from the risk assessment, and since these are the former IRIS values, these HEAST values were utilized. The toxicity value for



trans-1,2-dichloroethene was used for total 1,2-dichloroethene; the cis isomer RfD is under review, and no RfD for total 1,2-dichloroethene exists. Chemicals under review on IRIS and lacking HEAST values are cobalt and isodrin, and these were not considered further. The RfD for manganese has been withdrawn from IRIS/HEAST, pending review, thereby eliminating manganese from further consideration.

Additional compounds for which there were no toxicity values include the metals, aluminum, cobalt and lead; the volatiles, benzene and trichloroethene; the semi-volatile, 1,4-dichlorobenzene; and the pesticides, alpha-, beta-, and delta-BHC, 4,4'-DDD and DDE, endosulfan II, and isodrin.

The compound trichloroethene is under review on IRIS and HEAST, with respect to its carcinogenic status and the assignment of an oral slope factor. Guidance from the USEPA Environmental Criteria and Assessment Office (Cincinnati, Ohio) suggests that the weight-of-evidence classification is on a C-B2 continuum, and states that the upper bound risk value/oral slope factor for trichloroethene ( $1.1\text{E-}02 \text{ (mg/kg/day)}^{-1}$ ) has been reviewed by the IRIS-CRAVE workgroup but has not been verified on IRIS at this time. This value was used in this risk assessment.

#### 2.5.5 Risk Characterization

In this final step of the baseline risk assessment, the estimated daily intakes calculated in the exposure assessment were used in conjunction with the risk values identified in the toxicity assessment. In this way any potential risk to human health due to ingestion of contaminants from the ground water near the ASL at FGGM was determined and quantified.

##### 2.5.5.1 Risk Characterization Methods for Noncarcinogens

To evaluate the potential risk posed by the noncarcinogenic contaminants at the site, the estimated daily intake for each contaminant was compared to the RfD for that compound. The ratio of the intake to the RfD was determined as the hazard quotient (HQ) for the compound in question. If the HQ was less than one, it was assumed that daily consumption of that compound over a person's lifetime at concentrations determined in the exposure assessment would result in no appreciable risk of deleterious effects. If the HQ for a given contaminant was equal to or greater than one, it was assumed that the level of risk associated with exposure to that compound was potentially significant and its effects should be investigated further.

In order to determine total noncarcinogenic risk for the exposure being evaluated, the HQs for all the compounds of interest were summed to

determine the hazard index (HI) regardless of type of associated toxicity. If the HI was less than one, then there was considered to be little or no noncarcinogenic risk to the public by the sum of exposures to all compounds of potential concern. If the HI was greater than one, further evaluation of the types of critical effects associated with each compound was required. Upon further evaluation, noncarcinogenic risk was additive only within type of critical effect, e.g., only effects within one organ system were additive. For example, the HI was calculated for all compounds causing liver effects. If within the type of effect, the HI for the type of effect was less than one, then the risk for that effect was acceptable. An HI was calculated in this way for each type of noncarcinogenic effect.

#### 2.5.5.2 Risk Characterization Methods for Carcinogens

For carcinogens, any exposure results in some risk even though it may be very small or even trivial. The carcinogenic risk posed by each contaminant was determined by multiplying the estimated daily intake by the slope factor. This yielded the potential excess cancer risk associated with a lifetime of exposure to that compound at the exposure levels or intakes estimated in the exposure assessment.

Carcinogenic risk is considered to be additive. Therefore, in order to determine the total carcinogenic risk posed by exposure to the ground water at the site, the risks of the individual contaminants were summed. Risks are expressed as probabilities, e.g., one-in-a-million. This level of risk is also denoted by  $10^{-6}$  or  $1E-6$ . This one-in-a-million level of risk is often referred to as the de minimis level of risk. Risks at or below this level cannot be differentiated from the background occurrence of cancer in the population. Remember that risks calculated in a risk assessment are potential risks and are the excess (i.e., over background) cancer risks due to exposure from the site.

The U.S. EPA's policy at CERCLA (Superfund) sites has been to select remedies that result in total excess carcinogenic risk falling within the range from  $10^{-6}$  (one in a million) to  $10^{-4}$  (one in 10,000). Risks that fall within this range are considered to be acceptable under certain circumstances which are specific to each site. Site-specific variables such as population density are considered to determine the acceptable risk level within this range of possible acceptable risks.



#### 2.5.5.3 Risk Characterization for Ingestion of Ground Water from the Water-Table Aquifer Near the ASL

Ingestion of ground water from the water-table aquifer (Upper Patapsco) by hypothetical residents was evaluated as an exposure scenario under both current use and possible future use of the ASL site. Since the exposure pathways and assumptions are essentially identical for both, the intakes and risks will be discussed with the understanding that they apply to either land use scenario, unless otherwise qualified.

The estimated daily intakes and risks associated with exposure to ground water from the water-table aquifer are summarized in Table 2.5-11 for noncarcinogenic compounds and in Table 2.5-12 for carcinogenic compounds. These tables include all the chemicals of concern within the water-table aquifer. Several of the listed chemicals of concern are lacking toxicity values, as specified in Tables 2.5-9 and 2.5-10. Those compounds for which toxicity values are not available (NA) or not determined (ND) cannot be quantitatively evaluated for risk and will be discussed qualitatively in Section 2.5.5.5.

Under the average exposure conditions for ingestion of ground water from the water-table aquifer, the total risk of adverse noncarcinogenic effects is negligible, since the HI (sum of the HQs) was less than one. However, for the RME scenario in which the water-table aquifer is used as a drinking water source, the HQ for arsenic exceeded one. Therefore, the HI (sum of the HQs) exceeded one as well. This indicates that if the water-table aquifer was used as a drinking water supply under RME assumptions, the risk of noncarcinogenic effects would exceed the acceptable level.

Since the total HI exceeded one for the RME scenario, the next step was to investigate the individual components of this risk. Only the HQ for arsenic exceeded one; therefore, consumption of this ground water under RME conditions, if not remediated, would exceed the threshold levels for adverse effects of arsenic. The noncarcinogenic effects of arsenic ingestion include hyperpigmentation (dark coloring of areas of skin) and keratosis (an overgrowth of horny tissue on areas of the skin).

The additional components of the noncarcinogenic risk do not individually exceed an HQ of one. The two compounds with the next highest HQs were heptachlor epoxide (pesticide) and barium. Ingestion of heptachlor epoxide primarily increases liver weight and causes liver lesions in animals. The effect of barium is to induce high blood pressure. The diversity of these effects limits a consideration of their toxic effects upon a common organ system, thereby limiting their potential for an additive effect.

The total excess cancer risk shown in Table 2.5-12 for average exposure to ground water in the water-table aquifer was  $4E-5$  or 4 in 100,000. This risk value was within potentially acceptable levels according to the EPA guidelines for remedial alternative evaluation described above. In the reasonable maximum exposure scenario the total excess cancer risk was  $4E-4$  or 4 in 10,000. This value exceeds the range of potentially acceptable risk values established by the EPA. As in the case of the noncarcinogenic risk, the major portion of the total cancer risk was due to arsenic. The type of cancer caused by the oral ingestion of arsenic is skin cancer, and this effect has been demonstrated in human populations. The next highest contributor to the cancer risk in this case was beryllium, which causes lung tumors and certain grossly observed tumors upon ingestion.

While the risks quantified for the current and future land use scenarios were similar, the actual risks under the possible future exposures have been overestimated. Future risks enumerated in this section are greater than even the maximum possible risks. Factors responsible for this are discussed in Section 2.5.5.5.

#### 2.5.5.4 Risk Characterization for Ingestion of Ground Water from the Confined Aquifer near the ASL

Ingestion of ground water from the confined (lower Patapsco) aquifer by hypothetical residents was evaluated as an exposure scenario under both current and potential future use of the sanitary landfill site. Since intakes and risks are virtually identical for either land use situation, the following discussion addresses both types of land use.

The estimated daily intakes and risks associated with exposure to ground water from this aquifer are summarized in Tables 2.5-13 (noncarcinogens) and 2.5-14 (carcinogens). In this exposure scenario all individual HQs and the total HI were less than one for both the average and RME scenarios. This indicated that the risk of adverse noncarcinogenic effects was acceptable for this pathway at an average or at an RME level.

The potential excess cancer risk in the average case was  $2E-5$  (2 in 100,000) while the RME risk was  $2E-4$  (2 in 10,000). The average risk is within the potentially acceptable range, while the RME risk exceeds this range. This indicates that if water is ingested from the lower Patapsco aquifer, using the assumptions of the RME, the potential risk of carcinogenic effects is unacceptable. The majority of the carcinogenic risk for the RME scenario is due to beryllium.



While the risks quantified for the current and future land use scenarios were similar, the actual risks under the possible future exposures have been overestimated. Future risks enumerated in this section are greater than even the maximum possible risks. Factors responsible for this are discussed in Section 2.5.5.5.

#### 2.5.5.5 Uncertainties in the Human Health Risk Assessment

There are uncertainties associated with the risk assessment process that can lead to either an under- or an over-estimation of risk. In general, however, the risk assessment process is a conservative one. The risk assessment for the ASL presents two levels of risk for each land use scenario. One level is based on average exposure assumptions (average risk) and the other is based on more conservative assumptions (RME risk), in order to generate a range for comparison. Each risk level has uncertainties associated with it which differ in magnitude from the other but are similar in the nature of the uncertainties involved.

The data evaluation step has some uncertainty associated with it due to the selection of potential compounds of concern from the total compounds detected. However, compounds of concern were selected based on specific criteria. The average concentration of a compound was first compared to the background concentration. If a compound was not detected in the background sample, it was automatically retained. If the compound was present at a level equal to or greater than 1.5 times the background, it was retained. Compounds with concentrations less than or equal to 1.5 times their background were eliminated, unless they had highly toxic or carcinogenic properties, in which case they were still retained. Compound levels were also compared to any field or trip blank data, and if they were present at levels greater than five times the blank they were retained. Three compounds were eliminated from this risk assessment based on comparison with blank data. Metals known to be naturally occurring and characterized as essential human nutrients were eliminated based on those properties (calcium, chloride, magnesium, potassium, and sodium). Based on this fairly conservative evaluation of the data, the overall additional risk, if any, that might be unaccounted for would not be appreciable.

The single, primary pathway for exposure is from the ingestion of ground water from both the water-table and the confined aquifers. The elimination of surface water or sediment exposure pathways was justified by the low potential for human exposure via surface water or sediment. Exposure via the ingestion of ground water may potentially occur under both the present and potential future land usage conditions, although neither of these exposures are known with certainty. In addition to the uncertainty with respect to the actual



exposure pathway, both the current and future exposures include estimations of offsite risks using data collected onsite. Further uncertainty, which lends itself to additional overestimation of risks under both scenarios, occurs due to the inability to project the extent of attenuation of compound concentrations due to degradation over time/distance, and in the case of the future risks, landfill capping. The exposure assumptions used in the average risk scenario or the RME scenario also lend their accompanying semiconservatism and conservatism, respectively, to the analyses.

Some of the uncertainty inherent in this risk assessment is based upon the uncertainty associated with the toxicity values used for several compounds. The current status of the toxicity values for several compounds was discussed in section 2.5.4 of this risk assessment. The use of non-IRIS values (i.e., HEAST) carries some uncertainty with respect to the level of review for each value. The use of former IRIS values for compounds under review, and the use of HEAST values for compounds under review, adds uncertainty with respect to the potential for these values to be modified at some undetermined time in the future. Uncertainty associated with compounds for which there are no toxicity values available adds an unmeasurable uncertainty to the ability to accurately depict risk, although the majority of compounds of concern had quantifiable risks associated with them.

Toxicity values (i.e., RfDs and slope factors) have been established using conservative interpretations of the studies from which they derive. The RfD is based on the level at which no or little toxic effects are seen, while the slope factor serves as an upper bound estimator for risk from individual compounds. The treatment of chromium as the trivalent form and the use of the toxicity value specific for this form, is warranted based on the absence of data to the contrary. The use of the toxicity value for the trans- isomer of 1,2-dichloroethene allowed estimation of toxicity for total 1,2-dichloroethene, although the trans- isomer is the more toxic of the cis- and trans- forms. This adds conservative uncertainty to any risk estimates.

In addition, certain compounds that were detected in ground water lack toxicity values, and hence these compounds do not factor into the quantitative risk assessment. Compounds lacking noncarcinogenic toxicity values (RfDs) include the following: metals (aluminum, cobalt and manganese), volatile organic compounds (benzene and trichloroethene), a semivolatile organic compound (1,4-dichlorobenzene), and pesticides (alpha-, beta-, and delta-BHC; 4,4'-DDD and 4,4'-DDE; endosulfan II; and isodrin). The toxic effects of these compounds cannot be quantified within this risk assessment, and may lend some degree of unaccounted risk. Several compounds occurring in the water-table aquifer, namely benzene, trichloroethene, 1,4-dichlorobenzene, alpha-, beta-, and delta-BHC, DDD and DDE, exert their toxic effects



predominantly upon the liver. While the relatively low individual levels of several of these compounds may not pose a substantial adverse health effect, their collective concentrations in the upper water-table aquifer may result in a potential to induce adverse liver effects.

The only compound lacking a carcinogenic slope factor was 1,1-dichloroethane. The inability to include this compound in the quantitation of risk for the ASL may introduce some amount of risk, but the relatively low level at which this compound was present does not lend itself to a substantial increase in risk.

#### 2.5.5.6 Risk Characterization Summary

##### Water-Table Aquifer

The ingestion of shallow ground water from the water-table aquifer by residents onsite does not occur at present and is not anticipated to occur in the future. The extent to which shallow ground water from the vicinity of the ASL (i.e., offsite) is or will be consumed is not known, either for current or future land use. Potential ground-water users offsite may exist in the Galloway Road area. In the future, no individual wells are likely to be permitted on or near a former landfill site in accordance with State regulations. Any potential future ingestion of ground water from the water-table aquifer without remediation is even less likely, since the landfill will probably be capped. However unlikely, risks from ingestion of ground water were quantified under both potential current and potential future land use scenarios.

Potential current consumption of water from the water-table aquifer near the ASL was acceptable for noncarcinogenic risk and perhaps acceptable for carcinogenic risk under the average exposure scenario. However, consumption of this shallow ground water exceeded the acceptable risk for both noncarcinogenic and carcinogenic risk under RME assumptions. The risks from potential future ingestion of shallow ground water, either onsite or offsite, would in theory be approximately the same as those for the current land use in the absence of any remediation. Future risks lower than those predicted under the current land use would actually result due to the anticipated remediation measure (i.e., capping). Risks quantified under current conditions would represent maximal estimations of future risks.

According to this baseline risk assessment, consumption of ground water from the confined aquifer is and would continue to be unacceptable without remediation, based primarily on the excess carcinogenic risk for the RME scenario. The HIs under both the average and RME scenarios were less than one, indicating acceptable noncarcinogenic risk. The estimates of excess

cancer risk from this exposure under average conditions is probably an acceptable level, while the RME risk is above an acceptable level of carcinogenic risk. Again, risks under future land uses would be attenuated compared to the risk levels estimated for current use, with current use risks serving as overestimated ceilings for future risks from the confined aquifer.

#### 2.5.6 Comparison of Observed Ground-Water Concentrations to Drinking Water Standards

After completion of the baseline risk assessment and before determination of remediation goals, RI/FS guidance dictates that applicable or relevant and appropriate requirements (ARARs) be identified. The following discussions compare concentrations found in ground water to drinking water regulations in the Safe Drinking Water Act (SDWA), which was originally enacted in 1974 to (1) establish maximum allowable concentrations for contaminants likely to be present in drinking water and likely to cause adverse health effects, and (2) require monitoring of drinking water systems.

The SDWA provides three types of drinking water criteria. National Primary Drinking Water Regulations (NPDWRs), either as Maximum Contaminant Levels (MCLs) or Treatment Technologies (TTs), are the enforceable primary drinking water standards promulgated under the SDWA. Maximum Contaminant Level Goals (MCLGs) are goals and not enforceable standards. They are the concentration at which no adverse health effects are expected in persons drinking the water containing the contaminant of concern. Secondary Maximum Contaminant Levels (SMCLs) protect public welfare as opposed to public health and cover chemicals that affect odor, taste, or appearance of water. They are not enforceable but offer guidance to improving quality of drinking water systems.

These drinking water standards apply to drinking water at the point of use, i.e., water from the tap. In an RI, they may serve a function analogous to soil ARARs, when ground-water contamination is considered. They do not apply to surface water, sediment, leachate, or passive gas samples.

Table 2.5-15 lists all the compounds of concern for the ASL and reports all media in which they were present in the vicinity of the ASL. Table 2.5-15 also notes the aquifer where the contaminants were found. If a compound was detected in more than one aquifer, the aquifer with the maximum concentration is denoted with an asterisk. Compound levels detected in media other than ground water (i.e., in surface water, sediment, or leachate) cannot be compared to drinking water standards, as these are not appropriate for media other than ground water.



Table 2.5-15 lists NPDWRs (either an MCL or a TT), MCLGs, and SMCLs for those compounds that have them. For the purposes of risk assessment, an average ground-water concentration was calculated for the water-table aquifer data and for the confined aquifer data. The highest of these two averages is the maximum average ground-water concentration. For the purpose of comparison, both the maximum observed ground-water concentration and the maximum of the average ground-water concentrations from either the water-table aquifer or the confined aquifer are given. The maximum ground-water concentration listed in this table is the maximum concentration reported in any ground-water sample from either aquifer in the vicinity of the ASL.

A comparison can be made between the observed concentrations in the aquifer, i.e., concentrations before any remediation is undertaken, and the drinking water standards for 23 of the compounds listed in Table 2.5-15. This table shows that for most compounds, both the maximum reported concentration and the maximum average concentration are lower than any of the drinking water standards. In other words, for these compounds, the water could be consumed with no resultant adverse health effects even without remediation. This is the case for MCLs for the following metals: arsenic, barium, chromium, copper, nickel, selenium, and silver; for the following volatile organic compounds: 1,2-dichloroethene, ethylbenzene, toluene, trichloroethene, and xylenes; for the following semivolatile organic compounds: 1,2-dichlorobenzene, and 1,4-dichlorobenzene; and for the following pesticides: gamma-BHC (lindane), endrin, heptachlor, heptachlor epoxide, and methoxychlor.

The maximum reported ground-water concentration for benzene exceeds the MCL, but the maximum average concentration is below the MCL. The MCLG (0  $\mu\text{g/L}$ ) for benzene has also been exceeded. The maximum average for trichloroethene also exceeds the MCLG of 0. However, it should be remembered that the MCLGs are goals and not enforceable standards.

For two compounds, beryllium and bis(2-ethylhexyl)phthalate, the maximum ground-water concentration exceeds the proposed MCL level, and the maximum average for bis(2-ethylhexyl)phthalate also exceeds the proposed MCL. While these values do not exceed enforceable limits at present, they may at a future date.

Only one compound, manganese, exceeds the SMCL. This is not an enforceable level, but it does suggest that the water quality (with respect to taste, odor, or color) may be affected. However, since this is the only compound for which such an effect is noted, it is probable that the water would show no highly adverse quality.

A comparison of existing, i.e., unremediated, ground-water concentrations with the drinking water standards shows that the drinking water standards are exceeded only for benzene. The maximum average ground-water concentration for benzene, however, is less than its MCL.



TABLE 2.5-1 CHEMICALS OF POTENTIAL CONCERN IN UPPER PATAPSCO AQUIFER SAMPLES FROM THE VICINITY OF THE ASL<sup>(a)</sup>

Compound	Number Detected	CRL (µg/L)	Range of Detected Values		Background <sup>(a)</sup> (µg/L)	Mean (µg/L)	Standard Deviation (µg/L)	95% UCL (µg/L)
			Minimum (µg/L)	Maximum (µg/L)				
METALS								
Aluminum	18	<112	132	20,700	5,340	3,470	5,290	6,020
Arsenic	13	<2.35	2.70	38.5	<2.35	7.34	10.3	12.3
Barium	19	<2.82	19.3	434	88.1	145	111	198
Beryllium	4	<1.12	1.55	2.12	<1.12	0.832	0.549	1.10
Calcium	19	<105	1,410	137,000	5,910	40,100	43,300	60,900
Chromium	3	<16.8	23.8	33.4	<16.8	11.6	7.72	15.3
Cobalt	2	<25.0	34.1	39.4	<25.0	15.1	7.70	18.8
Copper	1	<18.8	21.3	21.3	<18.8	10.0	2.73	11.3
Iron	19	<77.5	216	195,000	16,300	70,400	60,200	99,400
Lead	7	<4.47	6.62	18.3	10.9	5.23	4.70	7.50
Magnesium	19	<135	759	79,100	1,700	17,100	21,500	27,500
Manganese	19	<9.67	109	1,230	106	453	371	632
Nickel	1	<32.1	57.0	57.0	<32.1	18.2	9.40	22.7
Potassium	14	<1,240	1,760	97,000	2,040	16,000	24,500	27,800
Selenium	1	<2.53	3.44	3.44	<2.53	1.38	0.499	1.62
Silver	8	<0.333	0.450	1.28	<0.333	0.437	0.387	0.623
Sodium	19	<279	1,510	330,000	4,620	55,400	85,800	96,700
Vanadium	2	<27.6	48.8	50.4	<27.6	17.6	11.3	23.0
Zinc	11	<18.0	19.8	99.8	92.6	32.5	29.0	46.5
VOLATILE ORGANIC COMPOUNDS								
Benzene	12	<1.0	1.40	12.4	1.32	3.00	3.13	4.51
Chlorobenzene	3	<1.0	2.31	23.1	<1.0	2.57	6.03	5.48
Chloroform	1	<1.0	4.70	4.70	<1.0	0.721	0.964	1.19
1,1-Dichloroethane	3	<1.0	5.23	5.88	<1.0	1.29	1.88	2.20
1,2-Dichloroethane (total)	2	<5.0	13.2	13.2	<5.0	3.63	3.37	5.25
1,2-Dichloropropane	1	<1.0	2.57	2.57	<1.0	0.609	0.475	0.838
Ethylbenzene	8	<1.0	1.00	75.0	<1.0	8.52	18.1	17.2
Tetrachloroethene	1	<1.0	1.48	1.48	<1.0	0.552	0.225	0.660
Toluene	7	<1.0	1.00	10.0	3.20	2.44	3.18	3.97
Trichloroethene	1	<1.0	2.40	2.40	<1.0	0.600	0.436	0.810
Xylenes	8	<2.0	2.18	88.1	<2.0	8.50	20.6	18.4

(a) A total of 19 samples are summarized in this table.

(b) Background concentrations are from MW-4S.

TABLE 2.5-1 (Cont.)

Compound	Number Detected	CRL (µg/L)	Range of Detected Values		Background <sup>(a)</sup> (µg/L)	Mean (µg/L)	Standard Deviation (µg/L)	95% UCL (µg/L)
			Minimum (µg/L)	Maximum (µg/L)				
SEMIVOLATILE ORGANIC COMPOUNDS								
p-Chloro-m-cresol	2	<8.5	13.6	19.1	<8.5	5.52	3.92	7.42
1,2-Dichlorobenzene	1	<1.2	9.48	9.48	<1.2	1.07	2.04	2.05
1,4-Dichlorobenzene	5	<1.5	7.16	17.8	<1.5	3.24	4.76	5.53
Diethyl phthalate	5	<5.9	14.3	105	5.9	14.2	26.5	27.0
2,4-Dimethylphenol	1	<4.4	8.20	8.20	<4.4	2.52	1.38	3.18
Naphthalene	8	<0.50	3.53	24.0	<0.50	5.41	8.07	9.31
PESTICIDES								
Aldrin	2	<0.0074	0.030	0.052	<0.0074	0.0076	0.012	0.014
Alpha-BHC	6	<0.0025	0.0040	0.038	<0.0025	0.0062	0.011	0.012
Beta-BHC	2	<0.0099	0.013	0.020	<0.0099	0.0062	0.0038	0.0080
Delta-BHC	3	<0.0034	0.0060	0.098	<0.0034	0.011	0.027	0.024
4,4'-DDD	3	<0.0081	0.012	0.150	<0.0081	0.015	0.035	0.031
4,4'-DDE	2	<0.0039	0.0060	0.011	<0.0039	0.0026	0.0022	0.0037
4,4'-DDT	6	<0.0025	0.021	0.140	<0.0025	0.022	0.041	0.042
Dieldrin	6	<0.0074	0.010	0.140	<0.0074	0.015	0.032	0.030
Endosulfan I	9	<0.0025	0.0070	0.100	<0.0025	0.025	0.034	0.042
Endosulfan II	3	<0.0077	0.013	0.043	<0.0077	0.0072	0.0096	0.012
Endrin	4	<0.0176	0.021	0.110	<0.0176	0.020	0.029	0.034
Heptachlor	7	<0.0025	0.030	0.100	<0.0025	0.024	0.035	0.041
Heptachlor epoxide	9	<0.0063	0.012	0.130	<0.0063	0.028	0.042	0.048
Isodrin	7	<0.0025	0.0050	0.088	<0.0025	0.013	0.026	0.025
Lindane	12	<0.0025	0.0050	0.066	<0.0025	0.017	0.020	0.027
Methoxychlor	4	<0.0750	0.100	0.570	<0.0750	0.089	0.132	0.152



TABLE 2.5-2 CHEMICALS OF POTENTIAL CONCERN IN LOWER PATAPSCO AQUIFER SAMPLES FROM THE VICINITY OF THE ASL<sup>(a)</sup>

Compound	Number Detected	CRL (µg/L)	Range of Detected Values		Background** (µg/L)	Mean (µg/L)	Standard Deviation (µg/L)	95% UCL (µg/L)
			Minimum (µg/L)	Maximum (µg/L)				
METALS								
Aluminum	5	<112	515	3,970	1,490	1,730	1,430	3,500
Barium	5	<2.82	20.1	254	148	111	96.1	230
Beryllium	2	<1.12	1.62	2.42	<1.12	1.14	0.848	2.20
Calcium	5	<105	2,370	117,000	63,900	38,900	46,400	96,500
Cobalt	1	<25.0	36.6	36.6	<25.0	17.3	10.8	30.7
Iron	5	<77.5	170	5,100	490	2,690	2,030	5,200
Magnesium	5	<135	230	3,510	218	1,120	1,360	2,810
Manganese	4	<9.67	16.8	353	20.2	87.9	149	273
Nickel	1	<32.1	37.3	37.3	<32.1	20.3	9.50	32.1
Potassium	5	<1,240	1,800	58,800	201,000	25,300	28,900	61,100
Selenium	1	<2.53	3.15	3.15	4.03	1.64	0.843	2.69
Silver	3	<0.33	0.390	0.450	0.51	0.322	0.145	0.502
Sodium	5	<279	2,000	56,000	88,000	23,700	25,300	55,100
Zinc	5	<18.0	19.0	66.9	43.9	48.4	20.3	73.6
VOLATILE ORGANIC COMPOUNDS								
None Detected								
SEMIVOLATILE ORGANIC COMPOUNDS								
Bis(2-ethylhexyl)phthalate	1	<7.70	76.2	76.2	<7.70	18.3	32.4	58.5
PESTICIDES								
Aldrin	1	<0.0074	0.0090	0.0090	<0.0074	0.0048	0.0024	0.0077
Alpha-BHC	2	<0.0025	0.0050	0.012	<0.0025	0.0042	0.0047	0.010
Delta-BHC	1	<0.0025	0.0060	0.0060	<0.0025	0.0026	0.0019	0.0050
4,4'-DDT	2	<0.0025	0.050	0.065	0.013	0.024	0.031	0.063
Dieldrin	3	<0.0074	0.025	0.430	0.062	0.126	0.183	0.354
Heptachlor	2	<0.0025	0.063	0.068	0.016	0.027	0.035	0.071
Isodrin	2	<0.0025	0.0050	0.0070	<0.0025	0.0032	0.0027	0.0065
Methoxychlor	1	<0.0750	0.140	0.140	<0.0750	0.058	0.046	0.115

(a) A total of 5 samples are summarized in this table.

(b) Background concentrations are from MW4D.

TABLE 2.5-3 SUMMARY OF POTENTIAL EXPOSURE PATHWAYS UNDER CURRENT AND FUTURE LAND USES AT ASL

<u>Potentially Exposed Population</u>	<u>Exposure Pathway</u>	<u>Pathway Selected for Evaluation</u>	<u>Reason for Selection or Exclusion</u>
Residents	Ingestion of ground water from the vicinity of the ASL <u>under current land use</u>	Yes	This water may have limited potential for use as drinking water under current land uses
Residents	Ingestion of ground water from the vicinity of the ASL <u>under possible future land use</u>	Yes	Pathway is unlikely but will be evaluated since it might occur
Residents	Ingestion of ground water from leachate samples at ASL	No	This water is not used for drinking
Hunters	Direct contact with surface water or sediment	No	Few compounds of concern and infrequent exposure
Hunters	Inhalation of gases emitted from ASL	No	Gas concentrations within ASL are many times lower than levels likely to cause adverse effects
Fishermen	Consumption of fish which have bioaccumulated contaminants from surface water	No	Concentrations will be diluted before reaching fishable water and it is unlikely that enough fish can be consumed to cause an adverse effect



TABLE 2.5-4      ASSUMPTIONS USED TO ESTIMATE INTAKE OF COMPOUNDS OF CONCERN  
VIA INGESTION OF GROUND WATER

<u>Parameter</u>	<u>Average Exposure</u>	<u>Reasonable Maximum Exposure</u>
Age of Receptor (years)	Adult	Adult
Compound Concentration ( $\mu\text{g/L}$ )	Average	95th Percentile Upper Confidence Limit on Mean
Conversion Factor ( $\text{mg}/\mu\text{g}$ )	$10^{-3}$	$10^{-3}$
Ingestion Rate (L/day)	1.4	2.0
Exposure Frequency (days/year)	345	350
Exposure Duration (years)	9	30
Body Weight (kg)	70	70
Averaging Time (years)		
Noncancer	9	30
Cancer	70	70
Conversion Factor (days/year)	365	365

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Source: U.S. EPA 1989.

TABLE 2.5-5 CHRONIC INGESTION (ORAL) EXPOSURE ESTIMATES FOR NONCARCINOGENS IN UPPER PATAPSCO AQUIFER GROUND WATER

Parameter	Average Ground-Water Concentration ( $\mu\text{g/L}$ )	Reasonable Maximum Exposure Ground-Water Concentration ( $\mu\text{g/L}$ )	Average Oral Intake ( $\text{mg/kg-day}$ )	Reasonable Maximum Exposure Oral Intake ( $\text{mg/kg-day}$ )
<b>METALS</b>				
Arsenic	7.3E+0	1.2E+1	1.4E-4	3.4E-4
Barium	1.5E+2	2.0E+2	2.7E-3	5.4E-3
Beryllium	8.3E-1	1.1E+0	1.6E-5	3.0E-5
Chromium	1.2E+1	1.5E+1	2.2E-4	4.2E-4
Cobalt	1.5E+1	1.9E+1	2.9E-4	5.2E-4
Copper	1.0E+1	1.1E+1	1.9E-4	3.1E-4
Manganese	4.5E+2	6.3E+2	8.6E-3	1.7E-2
Nickel	1.8E+1	2.3E+1	3.4E-4	6.2E-4
Selenium	1.4E+0	1.6E+0	2.6E-5	4.4E-5
Silver	4.4E-1	6.2E-1	8.3E-6	1.7E-5
Vanadium	1.8E+1	2.3E+1	3.3E-4	6.3E-4
<b>VOLATILE ORGANIC COMPOUNDS</b>				
Benzene	3.0E+0	4.5E+0	5.7E-5	1.2E-4
Chlorobenzene	2.6E+0	5.5E+0	4.9E-5	1.5E-4
1,1-Dichloroethane	1.3E+0	2.2E+0	2.4E-5	6.0E-5
1,2-Dichloroethene (total)	3.6E+0	5.3E+0	6.9E-5	1.4E-4
Ethylbenzene	8.5E+0	1.7E+1	1.6E-4	4.7E-4
Toluene	2.4E+0	4.0E+0	4.6E-5	1.1E-4
Trichloroethene	6.0E-1	8.1E-1	1.1E-5	2.2E-5
Xylenes (total)	8.5E+0	1.8E+1	1.6E-4	5.0E-4
<b>SEMIVOLATILE ORGANIC COMPOUNDS</b>				
p-Chloro-m-cresol	5.5E+0	7.4E+0	1.0E-4	2.0E-4
1,2-Dichlorobenzene	1.1E+0	2.1E+0	2.0E-5	5.6E-5
1,4-Dichlorobenzene	3.2E+0	5.5E+0	6.1E-5	1.5E-4
Diethyl phthalate	1.4E+1	2.7E+1	2.7E-4	7.4E-4
2,4-Dimethylphenol	2.5E+0	3.2E+0	4.8E-5	8.7E-5
Napthalene	5.4E+0	9.3E+0	1.0E-4	2.6E-4



TABLE 2.5-5 (Cont.)

<u>Parameter</u>	<u>Average Ground-Water Concentration (<math>\mu\text{g/L}</math>)</u>	<u>Reasonable Maximum Exposure Ground-Water Concentration (<math>\mu\text{g/L}</math>)</u>	<u>Average Oral Intake (<math>\text{mg/kg}\cdot\text{day}</math>)</u>	<u>Reasonable Maximum Exposure Oral Intake (<math>\text{mg/kg}\cdot\text{day}</math>)</u>
PESTICIDES				
Aldrin	7.6E-3	1.4E-2	1.4E-7	3.8E-7
Alpha-BHC	6.2E-3	1.2E-2	1.2E-7	3.3E-7
Beta-BHC	6.2E-3	8.0E-3	1.2E-7	2.2E-7
Delta-BHC	1.1E-2	2.4E-2	2.1E-7	6.6E-7
Gamma-BHC (Lindane)	1.7E-2	2.7E-2	3.2E-7	7.4E-7
4,4'-DDD	1.5E-2	3.1E-2	2.8E-7	8.5E-7
4,4'-DDE	2.6E-3	3.7E-3	4.9E-8	1.0E-7
4,4'-DDT	2.2E-2	4.2E-2	4.2E-7	1.2E-6
Dieldrin	1.5E-2	3.0E-2	2.8E-7	8.2E-7
Endosulfan I	2.5E-2	4.2E-2	4.7E-7	1.2E-6
Endosulfan II	1.0E+5	1.2E-2	1.9E+0	3.3E-7
Endrin	2.4E-2	3.4E-2	3.8E-7	9.3E-7
Heptachlor	2.4E-2	4.1E-2	4.5E-7	1.1E-6
Heptachlor Epoxide	2.8E-2	4.8E-2	5.3E-7	1.3E-6
Isodrin	1.3E-2	2.5E-2	2.5E-7	6.8E-7
Methoxychlor	8.9E-2	1.5E-1	1.7E-6	4.2E-6

TABLE 2.5-6 CHRONIC INGESTION (ORAL) EXPOSURE ESTIMATES FOR CARCINOGENS IN UPPER PATAPSCO AQUIFER GROUND WATER

Parameter	Average Ground-Water Concentration ( $\mu\text{g/L}$ )	Reasonable Maximum Exposure Ground-Water Concentration ( $\mu\text{g/L}$ )	Average Oral Intake ( $\text{mg/kg}\cdot\text{day}$ )	Reasonable Maximum Exposure Oral Intake ( $\text{mg/kg}\cdot\text{day}$ )
METALS				
Arsenic	7.3E+0	1.2E+1	1.8E-5	1.4E-4
Beryllium	8.3E-1	1.1E+0	2.0E-6	1.3E-5
VOLATILE ORGANIC COMPOUNDS				
Benzene	3.0E+0	4.5E+0	7.3E-6	5.3E-5
1,1-Dichloroethane	1.3E+0	2.2E+0	3.1E-6	2.6E-5
Trichloroethene	6.0E-1	8.1E-1	1.5E-6	9.5E-6
SEMIVOLATILE ORGANIC COMPOUNDS				
1,4-Dichlorobenzene	3.2E+0	5.5E+0	7.9E-6	6.5E-5
PESTICIDES				
Aldrin	7.6E-3	1.4E-2	1.8E-8	1.6E-7
Alpha-BHC	6.2E-3	1.2E-2	1.5E-8	1.4E-7
Delta-BHC	6.2E-3	8.0E-3	1.5E-8	9.4E-8
Gamma-BHC (Lindane)	1.7E-2	2.7E-2	4.1E-8	3.2E-7
4,4'-DDD	1.5E-2	3.1E-2	3.6E-8	3.6E-7
4,4'-DDE	2.6E-3	3.7E-3	6.3E-9	4.3E-8
4,4'-DDT	2.2E-2	4.2E-2	5.3E-8	4.9E-7
Dieldrin	1.5E-2	3.0E-2	3.6E-8	3.5E-7
Heptachlor	2.4E-2	4.1E-2	5.8E-8	4.8E-7
Heptachlor Epoxide	2.8E-2	4.8E-2	6.8E-8	5.6E-7



TABLE 2.5-7 CHRONIC INGESTION (ORAL) EXPOSURE ESTIMATES FOR NONCARCINOGENS IN LOWER PATAPSCO AQUIFER GROUND WATER

Parameter	Average Ground-Water Concentration (µg/L)	Reasonable Maximum Exposure Ground-Water Concentration (µg/L)	Average Oral Intake (mg/kg·day)	Reasonable Maximum Exposure Oral Intake (mg/kg·day)
<b>METALS</b>				
Beryllium	1.1E+0	2.2E+0	2.2E-5	6.0E-5
Cobalt	1.7E+1	3.1E+1	3.3E-4	8.4E-4
Manganese	8.8E+1	2.7E+2	1.7E-3	7.5E-3
Nickel	2.0E+1	3.2E+1	3.8E-4	8.8E-4
<b>VOLATILE ORGANIC COMPOUNDS</b>				
None Detected				
<b>SEMI-VOLATILE ORGANIC COMPOUNDS</b>				
Bis(2-ethylhexyl)phthalate	1.8E+1	5.9E+1	3.5E-4	1.6E-3
<b>PESTICIDES</b>				
Aldrin	4.8E-3	7.7E-3	9.1E-8	2.1E-7
Alpha-BHC	4.2E-3	1.0E-2	7.9E-8	2.7E-7
Delta-BHC	2.6E-3	5.0E-3	4.9E-8	1.4E-7
4,4'-DDT	2.4E-2	6.3E-2	4.5E-7	1.7E-6
Dieldrin	1.3E-1	3.5E-1	2.4E-6	9.7E-6
Heptachlor	2.7E-2	7.1E-2	5.1E-7	1.9E-6
Isodrin	3.2E-3	6.5E-3	6.0E-8	1.8E-7
Methoxychlor	5.8E-2	1.2E-1	1.1E-6	3.2E-6

TABLE 2.5-8 CHRONIC INGESTION (ORAL) EXPOSURE ESTIMATES FOR CARCINOGENS IN LOWER PATAPSCO AQUIFER GROUND WATER

Parameter	Average Ground-Water Concentration ( $\mu\text{g/L}$ )	Reasonable Maximum Exposure Ground-Water Concentration ( $\mu\text{g/L}$ )	Average Oral Intake ( $\text{mg/kg}\cdot\text{day}$ )	Reasonable Maximum Exposure Oral Intake ( $\text{mg/kg}\cdot\text{day}$ )
METALS				
Beryllium	1.1E+0	2.2E+0	2.8E-6	2.6E-5
VOLATILE ORGANIC COMPOUNDS				
None Detected				
SEMIVOLATILE ORGANIC COMPOUNDS				
Bis(2-ethylhexyl)phthalate	1.8E+1	5.9E+1	4.4E-5	6.9E-4
PESTICIDES				
Aldrin	4.8E-3	7.7E-3	1.2E-8	9.0E-8
Alpha-BHC	4.2E-3	1.0E-2	1.0E-8	1.2E-7
4,4'-DDT	2.4E-2	6.3E-2	5.8E-8	7.4E-7
Dieldrin	1.3E-1	3.5E-1	3.1E-7	4.2E-6
Heptachlor	2.7E-2	7.1E-2	6.6E-8	8.3E-7



TABLE 2.5-9 TOXICITY VALUES AND EFFECTS FOR NONCARCINOGENIC COMPOUNDS OF CONCERN IN GROUND WATER

<u>Parameter</u>	<u>Chronic Oral RfD (mg/kg-day)</u>	<u>Confidence Level (Chronic)</u>	<u>Critical Effect</u>	<u>RfD Basis/RfD Source</u>	<u>Uncertainty Factors</u>	<u>Modifying Factors</u>
<b>METALS</b>						
Aluminum	ND					
Arsenic (Inorganic)	3E-4 <sup>(a)</sup>	Medium	Keratosis; hyper-pigmentation	Water/IRIS	3	1
Barium	7E-2	Medium	High blood pressure	Water/IRIS	100	1
Beryllium	5E-3	Low	No adverse effects	Water/IRIS	100	1
Chromium: trivalent	1E+0	Low	Hepatotoxic	Food/IRIS	100	10
hexavalent	5E-3	Low	None	Water/IRIS	500	1
Cobalt	-----Under Review-----					
Copper <sup>(b)</sup>	4E-2		Local GI Irritation	Dose/HEAST		
Lead (Inorganic)	-----Pending Review-----					
Manganese	-----Withdrawn-----					
Mercury (Inorganic)	3E-4		Kidney effects	Parenteral/HEAST	1000	
Nickel (Soluble salt)	2E-2	Medium	Decrease body/organ weight	Food/IRIS	300	1

ND - Not Determined.

NA - Not Available.

Pending Review - Reference values are currently being assessed by internal EPA committees.

(a) Arsenic: IRIS value may vary by 2-3 fold; still under review.

(b) Copper: Calculated from the proposed MCL for drinking water of 1.3 mg/L.

(c) p-Chloro-m-cresol: Derived from sub-chronic oral RfD, using additional uncertainty factor of 10.

TABLE 2.5-9 (Cont.)

Parameter	Chronic Oral RfD (mg/kg-day)	Confidence Level (Chronic)	Critical Effect	RfD Basis/RfD Source	Uncertainty Factors	Modifying Factors
METALS (Cont.)						
Selenium	5E-3	High	Clinical selenosis	Human epidemiology/IRIS	3	1
Silver	5E-3	Low	Argyria	Human, i.v./IRIS	3	1
Vanadium	7E-3		None observed	Drinking water/HEAST	100	
Zinc	3E-1	Medium	Decrease red blood cell enzyme; altered copper status	Therapeutic Dose/IRIS	3	1
VOLATILE ORGANIC COMPOUNDS						
Benzene	-----Pending Review-----					
Chlorobenzene	2E-2	Medium	Liver histopathological effects	Capsule/IRIS	1,000	1
Chloroform	1E-2	Medium	Fatty liver cysts	Gelatin/IRIS	1,000	
1,1-Dichloroethane	1E-1 (Under Review)		No adverse effects		1,000	
1,2-Dichloroethene (total)	NA					
1,2-Dichloroethene (trans)	2E-2	Low	Increased serum alkaline phosphatase (males)	Water/IRIS	1,000	1
1,2-Dichloropropane	-----Data Inadequate-----					
Ethylbenzene	1E-1	Low	Liver/kidney damage (histopathology)	Gavage/IRIS	1,000	1
Tetrachloroethene	1E-2	Medium	Hepatotoxicity (mice); Weight gain (rats)	Gavage/IRIS	1,000	1



TABLE 2.5-9 (Cont.)

Parameter	Chronic Oral RfD (mg/kg day)	Confidence Level (Chronic)	Critical Effect	RfD Basis/RfD Source	Uncertainty Factors	Modifying Factors
METALS (Cont.)						
Toluene	2E-1	Medium	Liver/kidney weight changes	Gavage/IRIS	1,000	1
Trichloroethene	-----Pending Review-----					
Xylene (total)	2E+0	Medium	Hyperactivity; Decreased body weight; Increased mortality (males)	Gavage/IRIS	100	1
SEMIVOLATILES ORGANIC COMPOUNDS						
Bis(2-ethylhexyl)phthalate	2E-2	Medium	Increased relative liver weight	Diet/IRIS	1,000	1
p-Chloro-m-cresol	2E-1 <sup>40</sup>		Decreased weight	Gavage/HEAST	1,000	
1,2-Dichlorobenzene	9E-2	Low	No adverse effects	Gavage/IRIS	1,000	1
1,4-Dichlorobenzene	ND					
Diethyl phthalate	8E-1	Low	Decreased growth rate, food consumption, altered organ weights	Diet/IRIS	1,000	1
2,4-Dimethylphenol	2E-2	Low	Clinical signs (lethargy, prostration, ataxia) and hematological changes.	Gavage/IRIS	3,000	1
Naphthalene	4E-2		Decreased weight	Gavage/HEAST	1,000	
PESTICIDES						
4,4'-DDD	ND					
4,4'-DDE	ND					
4,4'-DDT	5E-4	Medium	Liver lesions	Diet/IRIS	100	1

TABLE 2.5-9 (Cont.)

<u>Parameter</u>	<u>Chronic Oral RfD (mg/kg day)</u>	<u>Confidence Level (Chronic)</u>	<u>Critical Effect</u>	<u>RfD Basis/RfD Source</u>	<u>Uncertainty Factors</u>	<u>Modifying Factors</u>
PESTICIDES (Cont.)						
Aldrin	3E-5	Medium	Liver toxicity	Diet/IRIS	1,000	1
Alpha-BHC	NA					
Beta-BHC	NA					
Delta-BHC	NA					
Gamma-BHC (Lindane)	3E-4	Medium	Liver and kidney	Diet/IRIS	1,000	1
Dieldrin	5E-5	Medium	Liver lesions	Diet/IRIS	100	1
Endosulfan I	5E-5	Medium	Kidney toxicity	Diet/IRIS	3,000	1
Endosulfan II	ND					
Endrin	3E-4	Medium	Mild histological liver lesions; occasional convulsions	Diet/IRIS	100	1
Heptachlor	5E-4	Low	Liver weight increase (males)	Diet/IRIS	300	1
Heptachlor epoxide	1.3E-5	Low	Increased liver to body weight ratio (male/female dogs)	Diet/IRIS	1,000	1
Isodrin	ND					
Methoxychlor	5E-3	Low	Teratology; Excessive litter loss (abortions)	Diet/IRIS	1,000	1



TABLE 2.5-10 CARCINOGENICITY VALUES FOR POTENTIAL CARCINOGENIC COMPOUNDS OF CONCERN IN GROUND WATER

<u>Parameter</u>	<u>Oral Slope Factor (mg/kg·day)<sup>-1</sup></u>	<u>Weight of Evidence Class</u>	<u>Type of Cancer</u>	<u>SF Basis/SF Source</u>
<b>METALS</b>				
Arsenic <sup>(a)</sup>	1.8E+0	A	Skin	Water/IRIS
Beryllium	4.3E+0	B2	Gross tumors	Water/IRIS
Cadmium	NA	B1		
Lead (Inorganic)	NA	B2	Kidney	
<b>VOLATILE ORGANIC COMPOUNDS</b>				
Benzene	2.9E-2	A	Leukemia, mammary	Air/HEAST (Worker)
Chloroform	6.1E-3	B2	Kidney	Water/IRIS
1,1-Dichloroethane	ND	C	Mammary adeno- carcinoma, hemangiosarcoma, hepatocellular carcinoma	Gavage/HEAST
1,2-Dichloropropane	6.8E-2	B2	Liver	Gavage/HEAST
Tetrachloroethene	5.1E-2	C/B2	Liver	Gavage/HEAST
Trichloroethene	1.1E-2	C/B2	Liver	Gavage/HEAST

ND = Not Determined.

NA = Not Available.

Weight of Evidence Classification:

A = a human carcinogen.

B1 = a probable human carcinogen; limited human data are available.

B2 = a probable human carcinogen; sufficient animal data with no or inadequate human data.

C = a possible human carcinogen.

(a) Arsenic: Slope Factor is derived from an oral Unit Risk value.

TABLE 2.5-10 (Cont.)

<u>Parameter</u>	<u>Oral Slope Factor (mg/kg·day)<sup>-1</sup></u>	<u>Weight of Evidence Class</u>	<u>Type of Cancer</u>	<u>SF Basis/SF Source</u>
SEMIVOLATILE ORGANIC COMPOUNDS				
Bis(2-ethylhexyl)phthalate	1.4E-2	B2	Liver	Diet/IRIS
1,4-Dichlorobenzene	2.4E-2	C	Liver	Gavage/HEAST92
PESTICIDES				
4,4'-DDD	2.4E-1	B2	Lung, liver, and thyroid tumors	Diet/IRIS
4,4'-DDE	3.4E-1	B2	Liver and thyroid tumors	Diet/IRIS
4,4'-DDT	3.4E-1	B2	Liver	Diet/IRIS
Aldrin	1.7E+1	B2	Liver carcinomas	Diet/IRIS
Alpha-BHC	6.3E+0	B2	Liver tumors	Diet/IRIS
Beta-BHC	1.8E+0	C	Hepatocellular carcinomas, hepatic nodules	Diet/IRIS
Dieldrin	1.6E+1	B2	Liver tumors, pulmonary metastases	Diet/IRIS
Heptachlor	4.5E+0	B2	Benign and malignant liver tumors	Diet/IRIS
Heptachlor epoxide	9.1E+0	B2	Liver tumors	Diet/IRIS



TABLE 2.5-11 CHRONIC INGESTION (ORAL) RISK ESTIMATES FOR NONCARCINOGENS IN UPPER PATAPSCO AQUIFER GROUND WATER

<u>Parameter</u>	<u>Average Oral Intake (mg/kg·day)</u>	<u>Reasonable Maximum Exposure Oral Intake (mg/kg·day)</u>	<u>Oral RfD (mg/kg·day)</u>	<u>Average Hazard Quotient</u>	<u>Reasonable Maximum Exposure Hazard Quotient</u>
<b>METALS</b>					
Arsenic	1.4E-4	3.4E-4	3E-4	4.6E-1	1.1E+0
Barium	2.7E-3	5.4E-3	7E-2	3.9E-2	7.7E-2
Beryllium	1.6E-5	3.0E-5	5E-3	3.1E-3	6.0E-3
Chromium	2.2E-4	4.2E-4	1E+0	2.2E-4	4.2E-4
Cobalt	2.9E-4	5.2E-4	ND	---	---
Copper	1.9E-4	3.1E-4	4E-2	4.7E-3	7.7E-3
Manganese	8.6E-3	1.7E-2	Withdrawn	---	---
Nickel	3.4E-4	6.2E-4	2E-2	1.7E-2	3.1E-2
Selenium	2.6E-5	4.4E-5	5E-3	5.2E-3	8.9E-3
Silver	8.3E-6	1.7E-5	5E-3	1.7E-3	3.4E-3
Vanadium	3.3E-4	6.3E-4	7E-3	4.8E-2	9.0E-2
<b>VOLATILE ORGANIC COMPOUNDS</b>					
Benzene	5.7E-5	1.2E-4	Pending	---	---
Chlorobenzene	4.9E-5	1.5E-4	2E-2	2.4E-3	7.5E-3
1,1-Dichloroethane	2.4E-5	6.0E-5	1E-1	2.4E-4	6.0E-4
1,2-Dichloroethane (total)	6.9E-5	1.4E-4	2E-2	3.4E-3	7.5E-3
Ethylbenzene	1.6E-4	4.7E-4	1E-1	1.6E-3	4.7E-3
Toluene	4.6E-5	1.1E-4	2E-1	2.3E-4	5.4E-4
Trichloroethene	1.1E-5	2.2E-5	Pending	---	---
Xylenes (total)	1.6E-4	5.0E-4	2E+0	8.0E-5	2.5E-4
<b>SEMIVOLATILE ORGANIC COMPOUNDS</b>					
p-Chloro-m-cresol	1.0E-4	2.0E-4	2E-1	5.2E-4	1.0E-3
1,2-Dichlorobenzene	2.0E-5	5.6E-5	9E-2	2.2E-4	6.2E-4
1,4-Dichlorobenzene	6.1E-5	1.5E-4	ND	---	---
Diethyl phthalate	2.7E-4	7.4E-4	8E-1	3.4E-4	9.2E-4
2,4-Dimethylphenol	4.8E-5	8.7E-5	2E-2	2.4E-3	4.4E-3
Napthalene	1.0E-4	2.6E-4	4E-2	2.6E-3	6.4E-3

TABLE 2.5-11 (Cont.)

Parameter	Average Oral Intake (mg/kg·day)	Reasonable Maximum Exposure Oral Intake (mg/kg·day)	Oral RfD (mg/kg·day)	Average Hazard Quotient	Reasonable Maximum Exposure Hazard Quotient
PESTICIDES					
Aldrin	1.4E-7	3.8E-7	3E-5	4.8E-3	1.3E-2
Alpha-BHC	1.2E-7	3.3E-7	NA	---	---
Beta-BHC	1.2E-7	2.2E-7	NA	---	---
Delta-BHC	2.1E-7	6.6E-7	NA	---	---
Gamma-BHC (Lindane)	3.2E-7	7.4E-7	3E-4	1.1E-3	2.5E-3
4,4'-DDD	2.8E-7	8.5E-7	ND	---	---
4,4'-DDE	4.9E-8	1.0E-7	ND	---	---
4,4'-DDT	4.2E-7	1.2E-6	5E-4	8.3E-4	2.3E-3
Dieldrin	2.8E-7	8.2E-7	5E-5	5.7E-3	1.6E-2
Endosulfan I	4.7E-7	1.2E-6	5E-5	9.5E-3	2.3E-2
Endosulfan II	1.9E+0	3.3E-7	---	---	---
Endrin	3.8E-7	9.3E-7	3E-4	1.3E-3	3.1E-3
Heptachlor	4.5E-7	1.1E-6	5E-4	9.1E-4	2.2E-3
Heptachlor Epoxide	5.3E-7	1.3E-6	1.3E-5	4.1E-2	1.0E-1
Isodrin	2.5E-7	6.8E-7	---	---	---
Methoxychlor	1.7E-6	4.2E-6	5E-3	3.4E-4	8.3E-4

Average Hazard Index = 7E-1 or 0.7

Reasonable Maximum Exposure (RME) Hazard Index = 2E+0 or 2.0



TABLE 2.5-12 CHRONIC INGESTION (ORAL) RISK ESTIMATES FOR CARCINOGENS IN UPPER PATAPSCO AQUIFER GROUND WATER

Parameter	Average Oral Intake (mg/kg·day)	Reasonable Maximum Exposure Oral Intake (mg/kg·day)	Oral Slope Factor (mg/kg·day) <sup>-1</sup>	Average Risk	Reasonable Maximum Exposure Risk
<b>METALS</b>					
Arsenic	1.8E-5	1.4E-4	1.8E+0	3.2E-5	2.6E-4
Beryllium	2.0E-6	1.3E-5	4.3E+0	8.7E-6	5.6E-5
<b>VOLATILE ORGANIC COMPOUNDS</b>					
Benzene	7.3E-6	5.3E-5	2.9E-2	2.1E-7	1.5E-6
1,1-Dichloroethane	3.1E-6	2.6E-5	ND	0.0E+0	0.0E+0
Trichloroethane	1.5E-6	9.5E-6	1.1E-2	1.6E-8	1.0E-7
<b>SEMIVOLATILE ORGANIC COMPOUNDS</b>					
1,4-Dichlorobenzene	7.9E-6	6.5E-5	2.4E-2	1.9E-7	1.6E-6
<b>PESTICIDES</b>					
Aldrin	1.8E-8	1.6E-7	1.7E+1	3.1E-7	2.8E-6
Alpha-BHC	1.5E-8	1.4E-7	6.3E+0	9.5E-8	8.9E-7
Beta-BHC	1.5E-8	9.4E-8	1.8E+0	2.7E-8	1.7E-7
Gamma-BHC (Lindane)	4.1E-8	3.2E-7	1.8E+0	7.4E-8	5.7E-7
4,4'-DDD	3.6E-8	3.6E-7	2.4E-1	8.7E-9	8.7E-8
4,4'-DDE	6.3E-9	4.3E-8	3.4E-1	2.1E-9	1.5E-8
4,4'-DDT	5.3E-8	4.9E-7	3.4E-1	1.8E-8	1.7E-7
Dieldrin	3.6E-8	3.5E-7	1.6E+1	5.8E-7	5.6E-6
Heptachlor	5.8E-8	4.8E-7	4.5E+0	2.6E-7	2.2E-6
Heptachlor Epoxide	6.8E-8	5.6E-7	9.1E+0	6.2E-7	5.1E-6

Total Excess Lifetime Cancer Risk, Average Case = 4E-5

Total Excess Lifetime Cancer Risk, Reasonable Maximum Exposure (RME) = 3E-4

TABLE 2.5-13 CHRONIC INGESTION (ORAL) RISK ESTIMATES FOR NONCARCINOGENS IN LOWER PATAPSCO AQUIFER GROUND WATER

Parameter	Average Oral Intake (mg/kg·day)	Reasonable Maximum Exposure Oral Intake (mg/kg·day)	Oral RfD (mg/kg·day)	Average Hazard Quotient	Reasonable Maximum Exposure Hazard Quotient
<b>METALS</b>					
Beryllium	2.2E-5	6.0E-5	5E-3	4.3E-3	1.2E-2
Cobalt	3.3E-4	8.4E-4	ND	---	---
Manganese	1.7E-3	7.5E-3	Withdrawn	---	---
Nickel	3.8E-4	8.8E-4	2E-2	1.9E-2	4.4E-2
<b>VOLATILE ORGANIC COMPOUNDS</b>					
None Detected					
<b>SEMIVOLATILE ORGANIC COMPOUNDS</b>					
Bis(2-ethylhexyl)phthalate	3.5E-4	1.6E-3	2E-2	1.7E-2	8.0E-2
<b>PESTICIDES</b>					
Aldrin	9.1E-8	2.1E-7	3E-5	3.0E-3	7.0E-3
Alpha-BHC	7.9E-8	2.7E-7	NA	---	---
Delta-BHC	4.9E-8	1.4E-7	NA	---	---
4,4'-DDT	4.5E-7	1.7E-6	5E-4	9.1E-4	3.5E-3
Dieldrin	2.4E-6	9.7E-6	5E-5	4.8E-2	1.9E-1
Heptachlor	5.1E-7	1.9E-6	5E-4	1.0E-3	3.9E-3
Isodrin	6.0E-8	1.8E-7	ND	---	---
Methoxychlor	1.1E-6	3.2E-6	5E-3	2.2E-4	6.3E-4
Average Hazard Index = 1E-1 or 0.1					
Reasonable Maximum Exposure (RME) Hazard Index = 5E-1 or 0.5					

ND = Not determined.  
NA = Not available.



TABLE 2.5-14 CHRONIC INGESTION (ORAL) RISK ESTIMATES FOR CARCINOGENS IN LOWER PATAPSCO AQUIFER GROUND WATER

Parameter	Average Oral Intake (mg/kg-day)	Reasonable Maximum Exposure Oral Intake (mg/kg-day)	Oral Slope Factor (mg/kg-day) <sup>-1</sup>	Average Risk	Reasonable Maximum Exposure Risk
METALS					
Beryllium	2.8E-6	2.6E-5	4.30E+0	1.2E-5	1.1E-4
VOLATILE ORGANIC COMPOUNDS					
None Detected					
SEMIVOLATILE ORGANIC COMPOUNDS					
Bis(2-ethylhexyl)phthalate	4.4E-5	6.9E-4	1.4E-2	6.2E-7	9.6E-6
PESTICIDES					
Aldrin	1.2E-8	9.0E-8	1.7E+1	2.0E-7	1.5E-6
Alpha-BHC	1.0E-8	1.2E-7	6.3E+0	6.4E-8	7.4E-7
4,4'-DDT	5.8E-8	7.4E-7	3.4E-1	2.0E-8	2.5E-7
Dieldrin	3.1E-7	4.2E-6	1.6E+1	4.9E-6	6.7E-5
Heptachlor	6.6E-8	8.3E-7	4.5E+0	3.0E-7	3.8E-6
Total Lifetime Excess Cancer Risk, Average Case = 2E-5					
Total Lifetime Excess Cancer Risk, Reasonable Maximum Exposure (RME) = 2E-4					

TABLE 2.5-15 DRINKING WATER STANDARDS AND OBSERVED GROUND WATER CONCENTRATIONS FOR CHEMICALS OF CONCERN FOUND AT ASL

Active Sanitary Landfill (ASL)						
Compound	Site/Media	NPDWR/MCL (mg/L)	SMCL (mg/L)	MCLG (mg/L)	Observed Ground-Water Concentration	
					Maximum (mg/L)	Maximum Average (mg/L)
METALS						
Arsenic	ASL1, sed, le	0.05			0.038	0.0073
Barium	ASL1, sed, le	2.0		2.0	0.43	0.145
Beryllium	ASL1, 2*	0.001 <sup>ω</sup>		0.0 <sup>ω</sup>	0.0024	0.00083
Chromium (Total)	ASL1, sed, le	0.1		0.1	0.033	0.0116
Cobalt	ASL1*, 2, sed, le				0.039	0.173
Copper	ASL1, sed, le	1.3/TT <sup>ω</sup>	1.0	1.3	0.021	0.01
Manganese	ASL1*, 2, sed, le, sw		0.05		1.23	0.453
Nickel	ASL1*, 2, sed, le	0.1 <sup>ω</sup>		0.1 <sup>ω</sup>	0.057	0.0203
Selenium	ASL1	0.05		0.05	0.003	0.00164
Silver	ASL1, sed, le	0.05	0.1		0.0013	0.000437
Vanadium	ASL1, sed, le				0.05	0.0176
VOLATILE ORGANIC COMPOUNDS						
Benzene	ASL1, le	0.005		0.0	0.012	0.003
Chlorobenzene	ASL1, le				0.023	0.00257
1,1-Dichloroethane	ASL1				0.0059	0.00129
cis-1,2-Dichloroethylene <sup>ω</sup>	ASL1	0.07		0.07	0.013 <sup>ω</sup>	0.00363 <sup>ω</sup>
trans-1,2-Dichloroethylene <sup>ω</sup>	ASL1	0.1		0.1	0.013 <sup>ω</sup>	0.00363 <sup>ω</sup>
Ethylbenzene	ASL1, le	0.7	0.03 <sup>ω</sup>	0.7	0.091	0.00852
Toluene	ASL1, le	1.0	0.04 <sup>ω</sup>	1.0	0.01	0.00244
Trichloroethylene	ASL1	0.005		0	0.0024	0.0006
Xylenes (Total)	ASL1, le	10.0	0.02 <sup>ω</sup>	10.0	0.008	0.0085

(a) Proposed standard.

(b) The NPDWR requires treatment actions if more than 10 percent of targeted tap samples exceed the action level (AL) of 1.3 mg/L for copper.

(c) The compound analyzed for in this RI was the combination of cis- and trans-1,2-dichloroethylene.

ASL1: Upper, water-table Patapsco aquifer at ASL.

ASL2: Lower, confined Patapsco aquifer at ASL sw, sed, le: The compound was also found in other media including surface water (sw), sediment (sed), or leachate (le).

\* Location of maximum concentration if compound was detected in both upper and lower aquifers.



TABLE 2.5-15 (Cont.)

Compound	Site/Media	NPDWR/MCL (mg/L)	SMCL (mg/L)	MCLG (mg/L)	Active Sanitary Landfill (ASL) Observed Ground-Water Concentration	
					Maximum (mg/L)	Maximum Average (mg/L)
SEMI-VOLATILE ORGANIC COMPOUNDS						
Bis(2-ethylhexyl)phthalate	ASL2, sed	0.004 <sup>w</sup>		0.0 <sup>w</sup>	0.0762	0.0183
p-Chloro-m-cresol	ASL1, le				0.019	0.0074
1,2-Dichlorobenzene	ASL1	0.6	0.01 <sup>w</sup>	0.6	0.0095	0.002
1,4-Dichlorobenzene	ASL1	0.075	0.005 <sup>w</sup>	0.075	0.0178	0.0055
Diethyl Phthalate	ASL1, le				0.105	0.027
2,4-Dimethylphenol	ASL1, le				0.0082	0.0032
Napthalene	ASL1, le				0.024	0.0093
PESTICIDES						
Aldrin	ASL1*, 2, sed				0.000052	0.0000076
Alpha-BHC	ASL1*, 2, le				0.000038	0.0000062
Beta-BHC	ASL1, le				0.00002	0.0000062
Delta-BHC	ASL1*, 2, le				0.000098	0.000011
Gamma-BHC (Lindane)	ASL, le	0.0002		0.0002	0.000066	0.000017
4,4'-DDD	ASL, sed				0.00015	0.000015
4,4'-DDE	ASL, sed, le				0.000011	0.0000026
4,4'-DDT	ASL1*, 2, sed, le				0.00014	0.000022
Dieldrin	ASL1, 2*, le				0.00043	0.000126
Endosulfan I	ASL1, sed, le				0.0001	0.000025
Endosulfan II	ASL1, sed, le				0.000043	0.0000072
Endrin	ASL1, sed			0.002 <sup>w</sup>	0.00011	0.00002
Heptachlor	ASL1*, 2, sed	0.0004		0.0	0.0001	0.000027
Heptachlor epoxide	ASL1, sed	0.0002		0.0	0.00013	0.000028
Isodrin	ASL1*, 2				0.000088	0.000013
Methoxychlor	ASL1*, 2, sed, le	0.04		0.04	0.00057	0.000089

## 2.6 PRELIMINARY QUALITATIVE ECOLOGICAL IMPACT ASSESSMENT

### 2.6.1 Introduction

Analysis of existing data collected for assessment of the Ft. Meade Active Sanitary Landfill (ASL) indicates that the nature and extent of the contamination may present a potential ecological risk to terrestrial and aquatic biota in the study area. The purpose to this section is to examine possible exposure pathways and ecological receptors which may be exposed to these contaminants and perform a preliminary qualitative assessment of potential risk.

### 2.6.2 Existing Data Summary

Surface water, stream sediment, leachate, soil and ground water samples were collected and analyzed as a component of the RI. Analytical results obtained from ground water, surface water, leachate, and sediment samples indicated pesticide contamination at levels of potential concern. Additional data from ground water and leachate samples taken adjacent to the southeastern ASL boundary revealed benzene concentrations below federal Water Quality Criteria. The data from the remaining samples did not reveal volatile organic or metals contaminants at levels of concern. Fisheries investigations near the ASL indicated incidences of external parasitism and other anomalies apparent on captured fish. These anomalies may indicate that surface water quality might be sufficiently degraded to cause stress and health effects on aquatic biota. Benthic investigations indicated a community indicative of a higher level of stress below the ASL relative to above the ASL. Additionally, an orange sheen/leachate was observed near dead and dying trees at the boundary of the ASL.

### 2.6.3 Conceptual Site Model Development

Analytical results of samples collected at or near the ASL have indicated that the ASL is a potential source of contamination to receptors on-site. This information, coupled with an examination of biota located at or adjacent to the ASL, has been used to develop a conceptual understanding of the site's potential risks to the environment. The conceptual site model (Figure 2.6-1)



includes known and suspected sources of contamination, affected media, known and potential routes of migration, and known or potential environmental receptors.

Infiltration/percolation, leachate, and runoff are the three primary release mechanisms by which ASL contaminants may reach receptor biota at Ft. Meade. The following section describes each of these release mechanisms, related contaminant pathways and the potential risks which may be present to biota.

#### 2.6.4 Completed Receptor Pathways

##### 2.6.4.1 Release Mechanisms

###### Infiltration/Percolation

Pesticides from the ASL may be impacting groundwater from the water-table aquifer as it flows beneath the landfill. Analytical results indicate that pesticides are present at low levels in all ground water samples. This potential impact may be enhanced during storm events as water percolates through the ASL and continues into the water-table aquifer. The groundwater may, as it continues to flow towards the Patuxent River, carry pesticides away from the landfill until the groundwater interacts with surface water and sediments at or near the ASL providing exposure to biota.

###### Leachate

Pesticides from the ASL may be impacting surface water and sediments through leachate. Analytical results of the leachate, sediment and surface water samples indicated concentrations of pesticides which exceeded chronic aquatic life criteria. Additionally, an orange leachate and sheen has been observed on the surface waters adjacent to the ASL. This leachate may have impacted surface water and sediments at or near the ASL.

###### Runoff

Pesticides from the ASL may be impacting the surface water and sediments through runoff across the ASL. During a rain event or winter thaw pesticides released from the ASL may contaminate runoff. Runoff water may then interact with surface water and sediments at or near the ASL providing exposure to biota.

#### 2.6.4.2 Secondary Sources

Pesticides found in the ASL may migrate via any of the previously discussed release mechanisms. Ultimately the pesticides are transported to a secondary source, such as surface water and sediments. This secondary source is the point at which biota are exposed to the pesticides through one of several exposure routes. As Figure 1 indicates, each of the release mechanisms potentially interacts with surface water and sediment at or near the ASL. Analytical results confirm that pesticide contamination is indeed migrating through the aforementioned release mechanisms to surface water and sediments. These contaminated sediments and surface waters are the means by which site biota become exposed to pesticide contamination associated with the ASL.

#### 2.6.4.3 Exposure Routes

Site biota are potentially exposed to pesticides via three modes of interaction: ingestion, food web facilitation, and direct contact. For persistent contaminants, such as organochlorine pesticides, food web exposure routes are generally important, due to the potential for the contaminants to bioaccumulate and bioconcentrate in the food web. For less persistent and/or bioaccumulative contaminants such as heavy metals and light organics, direct toxicity is expressed through ingestion or direct contact may be a crucial exposure pathway. For non-persistent contaminants the food web exposure is generally less important, while direct exposure to the contaminants becomes more significant.

#### 2.6.5 Biota Potentially Exposed

##### 2.6.5.1 Terrestrial

Terrestrial vegetation and wildlife are potential receptors at the ASL. Several vegetation communities are present in the area. A variety of terrestrial wildlife, including white-tailed deer, raccoons, red foxes, and raptors were identified as being present at the site, and the relatively rural and protected nature of the facility suggests that a rich biota is expected.

During the RI study, dead and dying trees were observed along the ASL boundaries. The cause of the tree mortality is not clear. None of the organic compounds detected in analysis is highly phyto-toxic. Certain metals, however were present in concentrations which may be toxic to vegetation. Another possible cause, or factor contributing to tree mortality is the area hydrology. Changes in the water-table may lead to death of certain upland species.



Terrestrial biota are potentially exposed to contamination through direct ingestion of surface water and/or sediments or through foodweb interactions. Thus the potential for ecological risks to terrestrial biota is present.

#### 2.6.5.2 Aquatic

Aquatic vegetation and wildlife are potential receptors of contaminants released from the ASL. During the RI, a variety of aquatic vegetation, and wildlife, including American eel, bluegill, pickerel and other fish were identified as being present at the site. Fish collected in the study area showed incidences of external parasitism and other anomalies. Such health effects are often associated with areas of degraded or contaminated water. Aquatic biota at the site are potentially exposed to contamination through direct ingestion of surface water and/or sediments, direct contact with surface water and sediments and/or through foodweb ingestion. Thus, the potential for ecological risks to terrestrial biota is present.

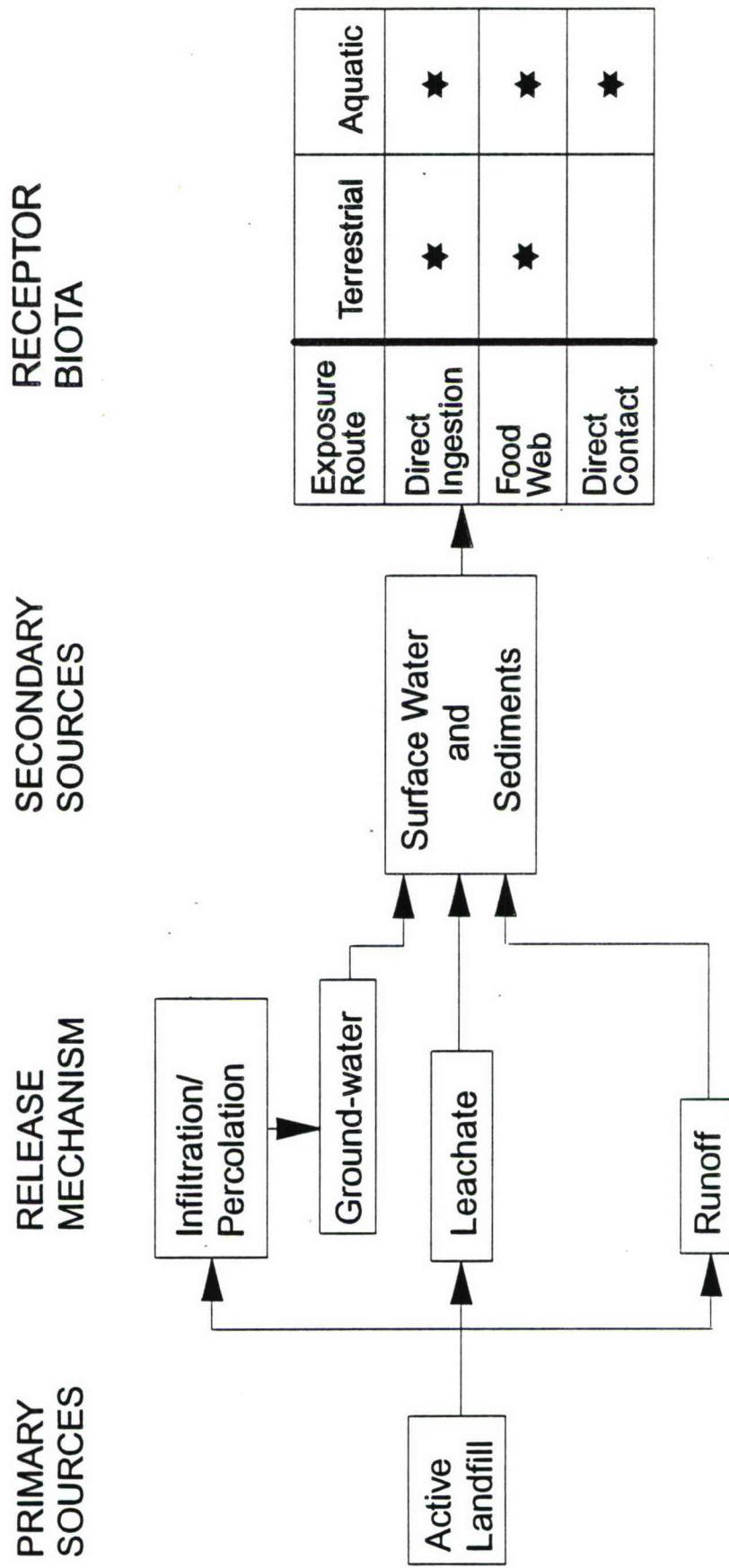


Figure 2.6-1 Ecological Conceptual Site Model for Fort Meade Active Sanitary Landfill



### 3. CLEAN FILL DUMP

#### 3.1 OBJECTIVES AND SCOPE OF WORK

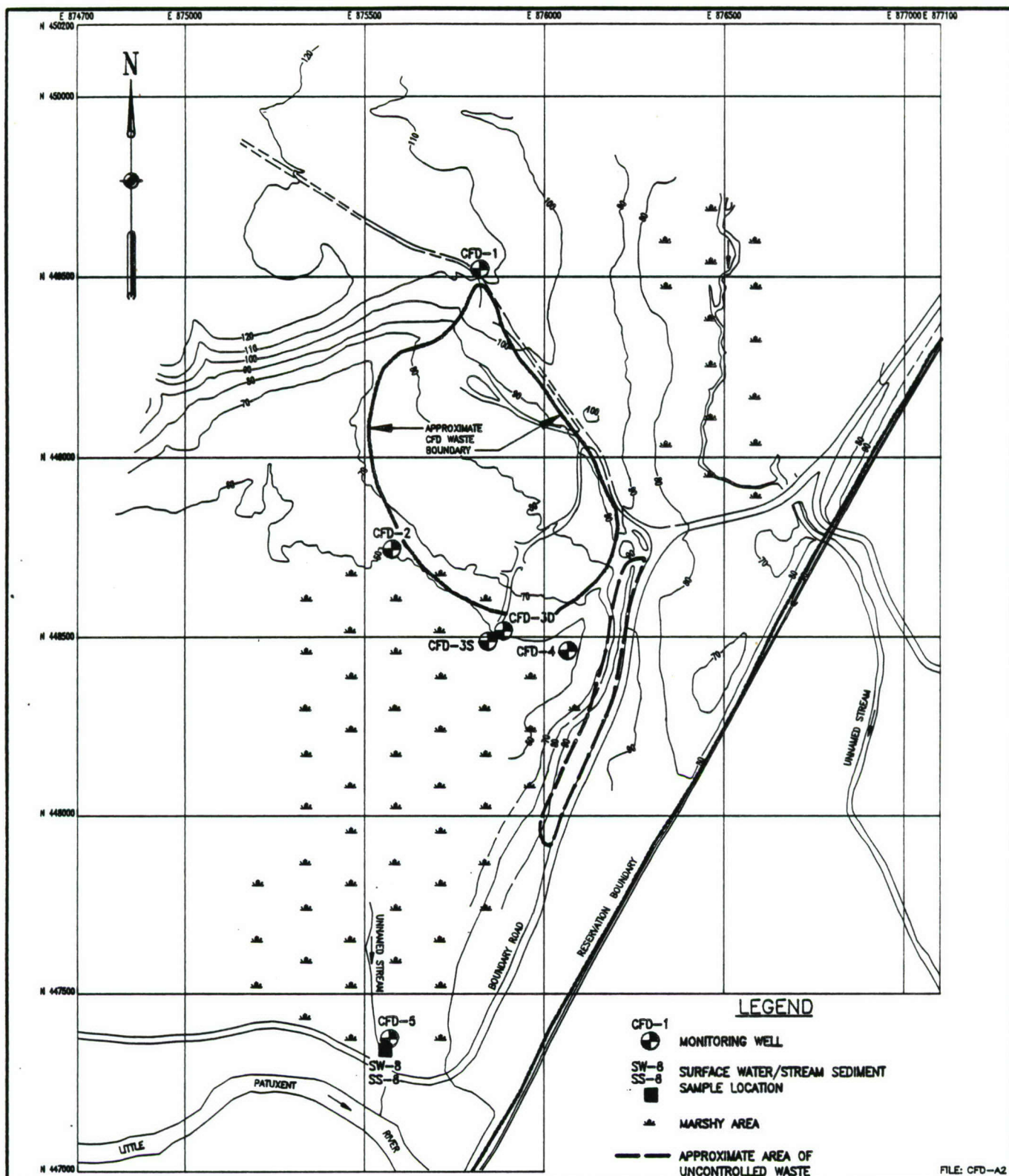
The objective of the CFD study was to characterize site geological, hydrogeological, and ecological conditions and assess the potential impact of the CFD on the environment and human health. The findings of this study were used to determine the need for additional studies.

The CFD was used for the disposal of combustible and noncombustible material such as wood, lumber, concrete, old appliances, and fill dirt. The U.S. Army Environmental Hygiene Agency (USAEHA) June 1989 report stated that garbage, food waste, cans, bottles, ashes, other putrescible matter, and possibly hazardous wastes may have been disposed at the CFD.

Figure 3.1-1 is a site map of the CFD area which shows the approximate waste boundary, location of monitoring points, and surface topography.

The following tasks were completed as part of the CFD study.

1. A surface water and stream sediment sample (SW/SS-8) was collected for chemical analysis downstream of the site from an unnamed tributary to the Little Patuxent River.
2. Phase I Well Installation  
One upgradient monitoring well (CFD-1) and four downgradient well points (CFD-2, CFD-3S, CFD-4, and CFD-5) were installed. Ground-water samples were collected for chemical analysis.
3. Phase II Well Installation  
One deep monitoring well (CFD-3D) was installed to complement an existing shallow well to form a two-well cluster.
4. Slug tests were conducted on two monitoring wells and three well points to provide information on hydraulic conductivity and ground-water velocity.
5. An ecological survey was conducted to characterize the terrestrial and aquatic resources and to assess the potential impact on these resources.



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CLEAN FILL DUMP  
SITE MAP

PROJECT MGR SAB	DESIGNED BY SAB	DRAWN BY MSM	CHECKED BY KWK	SCALE 1"=400'	DATE 10-21-91	PROJECT NO. 10559.05	FIGURE 3.1-1
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## 3.2 PHYSICAL CHARACTERIZATION

### 3.2.1 Surface Features

The CFD is located adjacent to Boundary Road along the southeastern FGGM boundary, approximately 1.5 mi south of the Sanitary Landfill in a less developed area of the installation. The CFD is surrounded by wooded areas on the north and east and by a low-lying marshy area to the south and west. An area of uncontrolled dumping of waste has occurred east and south of the site along Boundary Road outside of the approximate CFD waste boundaries.

The land surface elevation within the study area ranges from approximately 120 ft above MSL north of the fill area to 60 ft above MSL south of the landfill. A small unnamed perennial stream is located south of the study area. This stream is a tributary of the Little Patuxent River located approximately 1,000 ft south of the site. A beaver pond is located west of the site about 1,200 ft from the southern extent of the landfill.

### 3.2.2 Site Geology

The geology of the CFD area is shown in Figure 1.2-5 (Section 1.2). This figure shows that the silt-clay facies of the Potomac Group, the Patuxent River terrace deposits, and alluvium material deposited in the floodplain of the Little Patuxent River outcrop in this area. The Patuxent River terrace deposits consist of interbedded sand and gravel with lesser amounts of silty clay. The alluvium material consists of interbedded sand, silt-clay, and lesser amounts of gravel.

The boring logs for the two 4-in. diameter monitoring wells (CFD-1 and CFD-3D) and the four 2-in. diameter well points (CFD-2, CFD-3S, CFD-4, and CFD-5) are provided in Appendix C. CFD-1 and CFD-3D were installed using a drill rig to 55 and 70 ft below grade, respectively. Soil samples were collected in the borings for CFD-1 and CFD-3D at 5-ft intervals with a split-spoon sampler. The well points were installed with a hand auger to approximately 10 ft below grade. The subsurface material from the hand auger borings was classified at 2-ft intervals.

The upgradient well, CFD-1, is located at the top of a northwest/southeast-trending ridge. The soil samples collected from the CFD-1 boring indicate that the subsurface material consists primarily of multicolored clayey sand and silt with interbedded layers of clay and gravel. The material encountered during the hand augering for the well points (CFD-2, CFD-3S, and CFD-4) installed along the southern CFD boundary in the low-lying marshy area south of the fill area is underlain by alluvium consisting of yellowish to grayish

orange, silty medium sand with interbedded layers of coarse sand and gravel. The boring for well point CFD-5, located approximately 1,200 ft south of the CFD near an unnamed tributary of the Little Patuxent River, encountered the same type of alluvial material.

Soil samples were collected from the CFD-3D boring to a depth of 90 ft below grade. This boring encountered fine to coarse sand with some silt and gravel for the full depth of the boring except for an interval (5 to 10 ft thick) of clay and silt at approximately 45 to 55 ft below grade. It is uncertain whether this represents the middle confining layer encountered at the ASL.

### 3.2.3 Hydrogeology

The initial monitoring well (CFD-1) and four well points are screened in the water-table aquifer. The well installed in the second drilling phase (CFD-3D) produced a water-level approximately 3 ft higher than CFD-3S. It is not clear if this higher hydraulic head is attributable to a separate confined aquifer as encountered at the ASL or if the greater depth of CFD-3D (70 ft) compared to the well point (10 ft) resulted in a greater hydraulic head in the water-table aquifer. In either case, it is clear that the ground water has an upward vertical gradient in this area.

Water-level elevations obtained between 30 October 1989 and 27 July 1991 for the six monitoring wells/well points are shown in Table 3.2-1. A ground water contour map was constructed using water-level measurements (excluding CFD-3D) obtained on 27 July 1991 (Figure 3.2-1). This map shows that the ground-water flow direction in the water-table aquifer is to the south toward the marshy area immediately south of the site. This marshy area drains into the Little Patuxent River.

Slug tests were performed to estimate the hydraulic conductivity of the water-table aquifer, and the results of the tests are shown in Table 3.2-2. Estimated hydraulic conductivities ranged from  $7.64 \times 10^{-5}$  to  $4.31 \times 10^{-3}$  cm/sec. The estimated hydraulic conductivity value generated from the slug test performed in CFD-1 is representative of aquifers consisting of mixtures of sand, silt, and clay material. The values generated from the tests conducted in the well points are typical for aquifers composed of fine sand.

Using an average hydraulic conductivity of  $7.64 \times 10^{-3}$  ft/min (which was calculated from CFD-3S and CFD-5 hydraulic conductivity values obtained from the slug tests), an effective porosity of 0.3, a typical value for fine sand material, and the hydraulic gradient between CFD-3S and CFD-5 ( $6.25 \times 10^{-3}$  ft/ft), an estimated average ground-water velocity in this area would be on the order of  $2.29 \times 10^{-1}$  ft/day or 83.6 ft/year.



### 3.2.4 Terrestrial Resources

#### Land Cover/Use Characterization

Land cover and land use as defined earlier in this report are the natural landscape and man's utilization of the landscape, respectively. Land use and cover types were derived from review of historic and more recent aerial photos along with in-field confirmation of plant community distribution and fill material distribution.

The land cover components of the CFD are forested (10 acres), scrub-shrub (3 acres), and grassed fields and meadows (6 acres). The land uses of the CFD are waste disposal areas, including both field disposal cells and sporadic surface dumping in woodlands. The surrounding area is undeveloped woodland (wetlands) and marsh. Other identified uses of adjacent areas include recreational fishing areas at the nearby beaver pond and Little Patuxent River. The extreme northern and western edge of the upper CFD cell is on the periphery of the buffer of a currently used firing range (Range No. 7).

#### Upland Community Characterization

Two upland communities were identified at the CFD study area. The landfill cap is vegetated by an old field community which contained scattered trees and shrubs (Figure 3.2-2). Vegetation identified at the CFD old fields is listed in Table 3.2-3. The old field community is codominated by bushclover and grasses, predominantly tall fescue and orchard grass. Other old field species include purple-top grass, broom sedge, crab grass, Japanese chess, perennial bentgrass, yellow bristle grass, foxtail millet, Indian hemp, field thistle, bull thistle, yarrow, ragweed, asters, and goldenrods. Scattered trees were predominantly black locust and sweet gum. Shrubs included multiflora rose, common privet, and wineberry.

The uncovered fill area along the steeply sloped roadside and the woods adjacent to the north side of the CFD are vegetated by mature upland forest. Vegetation identified in the upland woods associated with the CFD is listed in Table 3.2-4. The upland woods along the northwestern boundary of the CFD and the roadside dump area were dominated by oaks. These included red, white, southern red, and scarlet oaks. Other canopy species included tulip tree, beech, sweet gum, loblolly pine, Virginia pine, black locust, black cherry, and red maple. The understory and shrub layers are open and included holly, beech, dogwood, chestnut, highbush blueberry, green brier, and pepperbush. Ground cover was dominated by Japanese honeysuckle and also included partridge berry, spangle grass, poison ivy, and ground cedar.

### Wetland Community Characterization

The CFD rises approximately 15-20 ft above a hardwood swamp along its southern boundary. The wooded wetlands along the south edge of the CFD were part of an extensive system of wetlands draining to the Little Patuxent River (Figure 3.2-3). Vegetation identified in the wetland study area of the CFD is listed in Table 3.2-5. Adjacent to the CFD the wetlands are dominated by red maple in the canopy and by sweet bay in the understory. Pepperbush dominated the shrub layer and cinnamon fern was the most common herbaceous species. Other canopy species included birch, sycamore, swamp white oak, pin oak, tulip poplar, and an occasional scrub pine. Understory shrub and vine species also included holly, highbush blueberry, swamp rose, and greenbrier. Herbaceous species also included fowl manna grass, swamp buttercup, peat moss, log clubmoss (Lycopodium inundatum), skunk cabbage, partridge berry, false nettle, sedges, and spangle grass. Hydrology of these wetlands was dominated by ground-water discharge from upgradient land including the CFD area.

The quality of these wetlands is relatively high. These wetlands exhibit ground-water discharge which helps to maintain the base flow of the ponds, downgradient streams, and river. The wetlands are structurally diverse with portions of hardwood swamp, shrub marsh, emergent marsh, and open water. These wetlands are expected to detain flood waters and act as sediment and toxicant traps by impeding flood flow during storm events. The wildlife habitat value of these wetlands is also high due to the interspersions of water and plants and diversity of the vegetation.

### Wildlife Resource Characterization

Wildlife habitat generally is of good quality in the area around the CFD. The northern fill cell of the dump is vegetated primarily with herbaceous vegetation. This area provides a break in the surrounding woodlands, and there is a shrub layer between the woodlands and the more open areas. This shrub edge includes privet, multiflora rose, wine berry, and highbush blueberry. The surrounding area includes mature upland woods along the steep-sloped eastern edge, a pine stand on the northwest edge, and upland hardwoods to the north. The remainder of the surrounding area is swamp which borders on ponded area and marsh land to the southwest. In general, this site area has a good mixture of habitat components. The adjacent ponded swamp and marsh areas provide ideal habitat for nesting ducks, especially wood ducks, and attract other birds such as great-blue heron. The marsh and ponds provide juvenile fish cover and food as well as habitat for frogs, turtles, and other wetland-dependent animals, such as beaver.

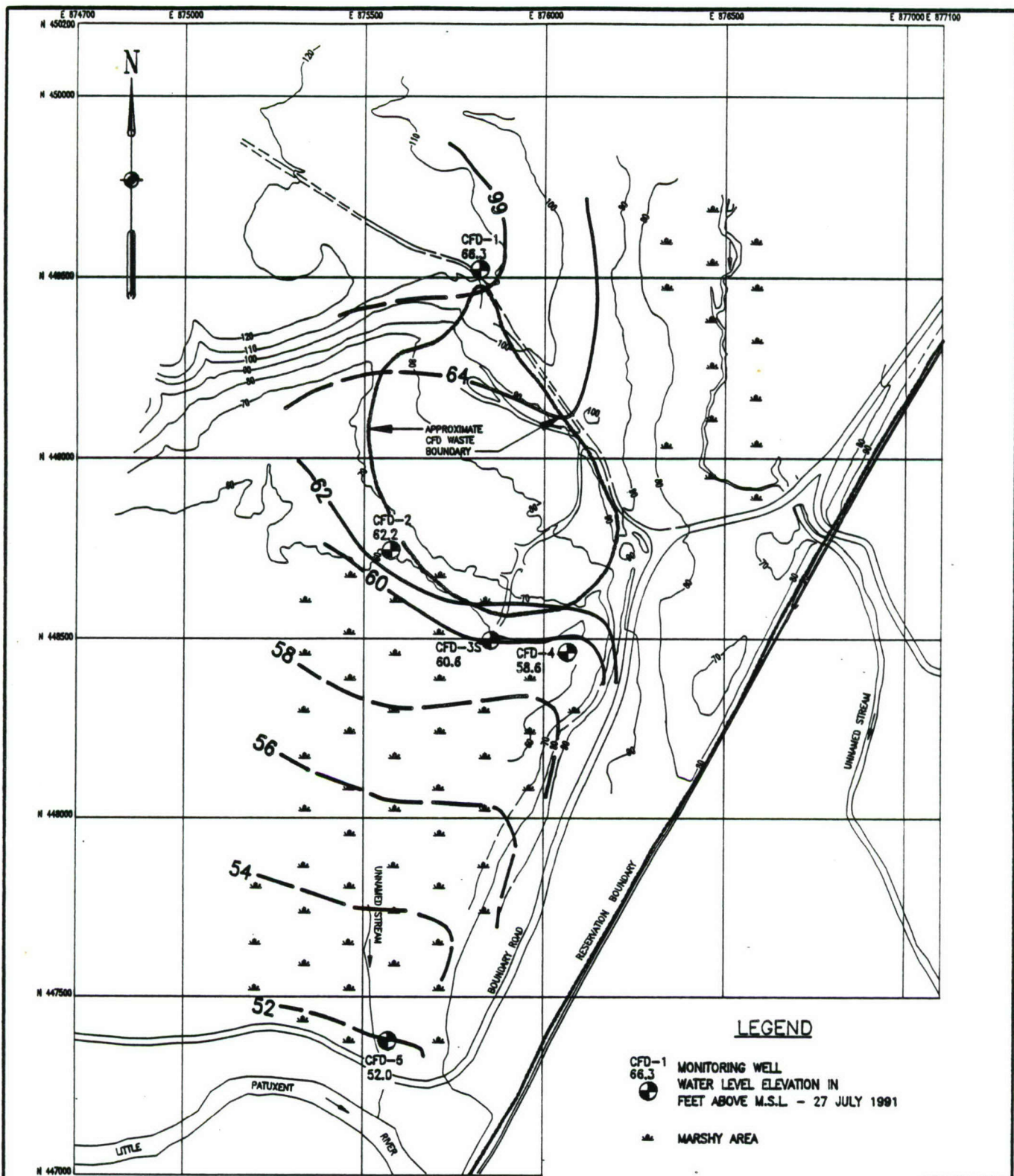


Wildlife species observed at and near the CFD include deer, Canada geese, wood ducks, mallards, great-blue heron, and woodcock. For a more complete list, refer to Table 3.2-6.

The elongated portion of the CFD along Boundary Road contains areas littered with hundreds of tires and rusted 55-gal drums. The appearance of these items and other containers and scrap material indicates that this part of the dump is older (probably 30 or 40 years old).

#### 3.2.5 Aquatic Resources Characterization

The surface waters of the CFD generally drain southward from the northern area of the CFD and westward from the long southern dump area to an unnamed tributary of the Little Patuxent River. The wooded area along the southern end of the fill area is a swamp which was ponded with several inches of water during EA's March 1991 field investigation. There is also a pond adjacent to the southern portion of the dump area in the vicinity of the base of the hill adjacent to Boundary Road. This ponded area is 50+ ft wide and a foot deep at the edge, and has an unconsolidated muck substrate. The ponded segments in the swamp woods at the south end of the northern fill cell contained stained areas, iridescent sheen, and orange floc.



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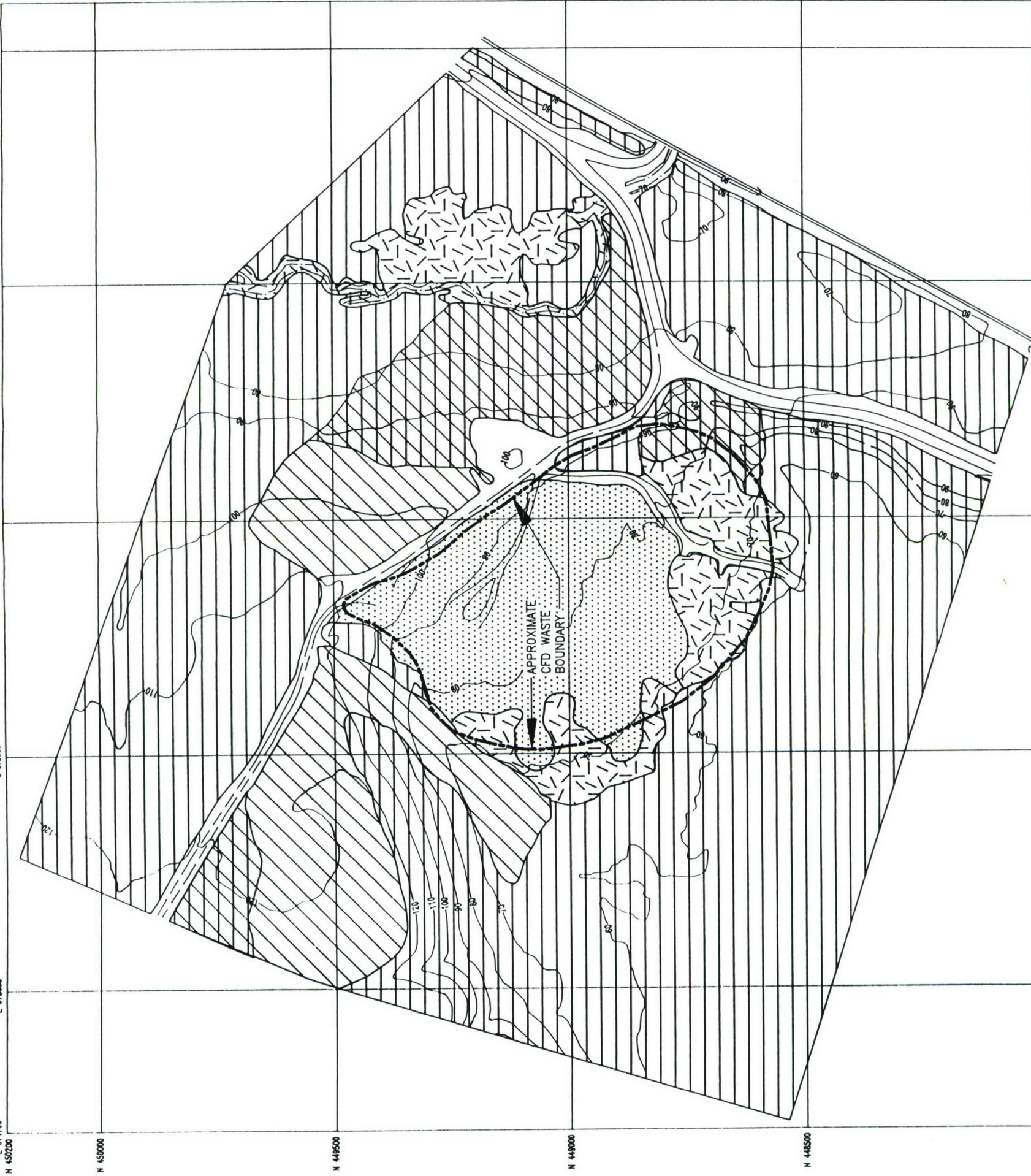
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FORT MEADE, MARYLAND

CLEAN FILL DUMP  
WATER-TABLE AQUIFER  
GROUND-WATER  
CONTOUR MAP

PROJECT MGR SAB	DESIGNED BY SAB	DRAWN BY MSM	CHECKED BY KWK	SCALE 1"=400'	DATE 10-21-91	PROJECT NO. 10559.05	FIGURE 3.2-1
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E 874700 E 875000 E 875300 E 875600 E 875900 E 876200  
N 439700 N 440000 N 440300 N 440600 N 440900



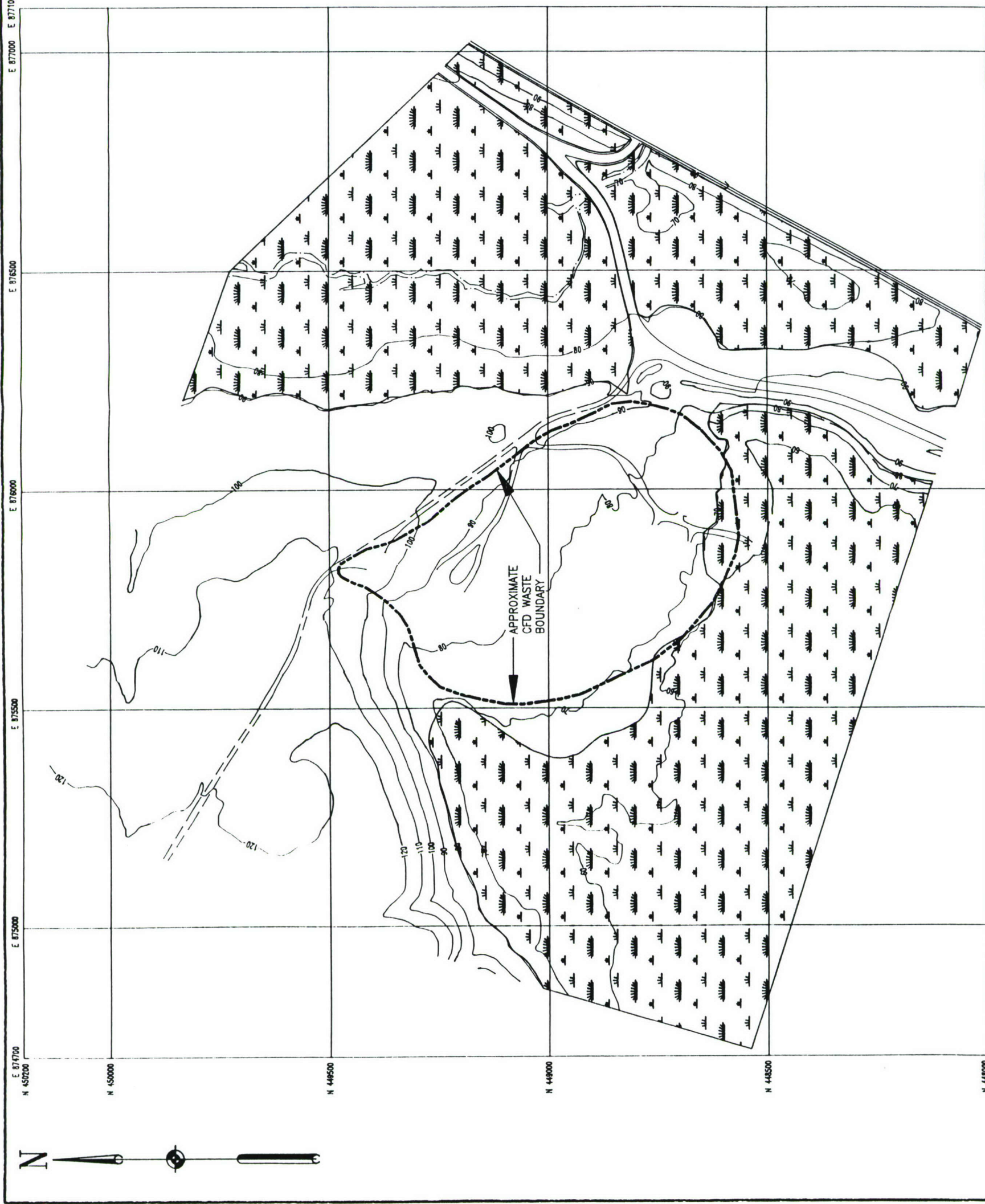
**LEGEND**

- IMPERVIOUS SURFACE/BARE SOIL
- PINEWOODS
- SCRUB/SHRUB
- DECIDUOUS WOODS
- HERBACEOUS/GRASSED
- MIXED PINE/DECIDUOUS WOODS
- TOPOGRAPHIC CONTOUR IN FEET ABOVE MSL

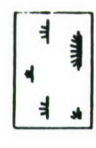


<b>EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.</b>	<b>FORT MEADE REMEDIATION INVESTIGATION FORT MEADE, MARYLAND</b>	<b>CLEAN FILL DUMP VEGETATIVE COMMUNITIES</b>		DESIGNED BY <b>EWM</b>	DRAWN BY <b>MSM</b>	DATE <b>9-30-91</b>	PROJECT NO. <b>10559.05</b>	FILE NAME <b>CFD-BVW</b>
				CHECKED BY <b>KWK</b>	PROJECT MGR. <b>SAB</b>	SCALE <b>1"=250'</b>	DRAWING NO. <b>-</b>	FIGURE <b>3.2-2</b>





**LEGEND**



NON-TIDAL WETLAND

TOPOGRAPHIC CONTOUR IN FEET ABOVE MSL

80



GRAPHIC SCALE IN FEET


	EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.		FORT MEADE REMEDIATION INVESTIGATION FORT MEADE, MARYLAND		CLEAN FILL DUMP NON-TIDAL WETLANDS MAP		DESIGNED BY EWM	DRAWN BY MSM	DATE 9-30-91	PROJECT NO. 10559.05	FILE NAME CFD-BW
							CHECKED BY KWK	PROJECT MGR. SAB	SCALE 1"=250'	DRAWING NO. -	FIGURE 3.2-3





TABLE 3.2-1 (Extended)

Well No.	Reference Elevation (ft)	Water-Level Elevation (ft)							
		AUG 90	SEP 90	OCT 90	1 NOV 90	26 NOV 90	10 JAN 91	12 FEB 91	27 JUL 91
CFD-1	115.82	66.96	-----	66.56	66.66	66.58	67.22	67.14	66.30
CFD-2	65.13	62.41	60.29	62.35	62.48	62.44	62.59	62.63	62.21
CFD-3S	63.54	60.72	60.81	60.74	60.78	60.80	60.89	60.90	60.63
CFD-3D	65.37	63.46	62.58	63.15	63.27	63.27	63.62	63.73	62.88
CFD-4	61.30	58.52	59.23	58.47	58.52	58.54	58.67	58.64	58.63
CFD-5	56.82	51.96	54.02	52.00	52.17	52.26	52.34	52.36	51.95



TABLE 3.2-2

HYDRAULIC CONDUCTIVITY VALUES DERIVED FROM SLUG TESTS  
CONDUCTED IN CFD MONITORING WELLS

<u>Well</u>	<u>cm/sec</u>
CFD-1	$7.64 \times 10^{-5}$
CFD-2	$2.39 \times 10^{-3}$
CFD-3S	$4.31 \times 10^{-3}$
CFD-3D	$1.69 \times 10^{-3}$
CFD-5	$3.46 \times 10^{-3}$

TABLE 3.2-3 VEGETATION IDENTIFIED IN THE OLD FIELD COMMUNITY OF THE CFD,  
FORT MEADE

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
TREES		
<u>Liquidambar styraciflua</u>	Sweetgum	FAC
<u>Robinia pseudoacacia</u>	Black locust	FACU
SHRUBS		
<u>Ligustrum vulgare</u>	European privet	FACU
<u>Rosa multiflora</u>	Multiflora rose	FACU
<u>Rubus phoenicolasius</u>	Wineberry	UP*
GRASSES, SEDGES, AND RUSHES		
<u>Agrostis perennans</u>	Perennial bentgrass	FACU
<u>Andropogon virginicus</u>	Broomsedge	FACU
<u>Bromus japonicus</u>	Japanese chess	FACU
<u>Dactylis glomerata</u>	Orchard grass	FACU
<u>Festuca pratensis</u>	Meadow fescue	FACU
<u>Setaria glauca</u>	Yellow bristle grass	FAC
<u>Setaria italica</u>	Foxtail millet	FACU
HERBS		
<u>Achillia millefolium</u>	Yarrow	FACU
<u>Ambrosia artemesifolia</u>	Common ragweed	FACU
<u>Asclepias syriaca</u>	Pink milkweed	UP*
<u>Aster spp</u>	Asters	UNK
<u>Cirsium arvense</u>	Canadian thistle	FACU
<u>Cirsium vulgare</u>	Bullthistle	FACU
<u>Daucus carota</u>	Queen Anne's Lace	UP*
<u>Lespedeza steuri</u>	Bush-clover	UP*
<u>Oenothera biennis</u>	Evening primrose	FACU
<u>Solidago rugosa</u>	Wrinkled goldenrod	FAC

(a) Hydrophytic status follows Reed, P.B. Jr. (1988) The U.S. Fish and Wildlife National List of Plant Species that Occur in Wetlands unless indicated otherwise. Abbreviations:

- OBL - Obligate (found in wetlands in more than 99% of all findings)
- FACW - Faculative wetland (66-99%)
- FAC - Faculative (33-66%)
- FACU - Faculative upland (1-33%)
- UP - Upland (<1%)

\* Hydrophytic status not reported; status presented is based on professional judgment and is supported by appropriate literature.



TABLE 3.2-4 VEGETATION IDENTIFIED IN UPLAND WOODS ASSOCIATED WITH THE CFD,  
FORT MEADE

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
<b>TREES</b>		
<u>Acer rubrum</u>	Red maple	FAC
<u>Cornus florida</u>	Dogwood	FACU
<u>Fagus grandifolia</u>	Beech	FACU
<u>Ilex opaca</u>	American holly	FACU
<u>Liquidambar styraciflua</u>	Sweetgum	FAC
<u>Liriodendron tulipifera</u>	Tulip tree	FACU
<u>Pinus taeda</u>	Loblolly pine	FAC
<u>Pinus virginiana</u>	Virginia pine	UP*
<u>Prunus serotina</u>	Black cherry	FACU
<u>Quercus alba</u>	White oak	FACU
<u>Quercus coccinea</u>	Scarlet oak	UP*
<u>Quercus falcata</u>	Southern red oak	FACU
<u>Quercus rubra</u>	Northern red oak	FACU
<u>Robinia pseudoacacia</u>	Black locust	FACU
<b>SHRUBS</b>		
<u>Castanea dentata</u>	American chestnut	UP*
<u>Clethra alnifolia</u>	Pepperbush	FAC
<u>Rubus flagellaris</u>	Dewberry	UP*
<u>Vaccinium corymbosum</u>	Highbush blueberry	FACW
<b>VINES</b>		
<u>Lonicera japonica</u>	Japanese honeysuckle	FAC
<u>Mitchella repens</u>	Partridge-berry	FACU
<u>Rhus radicans</u>	Poison ivy	FAC
<u>Smilax rotundifolia</u>	Greenbrier	FAC

(a) Hydrophytic status follows Reed, P.B. Jr. (1988) The U.S. Fish and Wildlife National List of Plant Species that Occur in Wetlands unless indicated otherwise. Abbreviations:

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FAC = Faculative (33-66%)

FACU = Faculative upland (1-33%)

UP = Upland (<1%)

\* Hydrophytic status not reported; status presented is based on professional judgment and is supported by appropriate literature.

TABLE 3.2-4 (Cont.)

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
FERNS AND FERN ALLIES		
<u>Lycopodium</u> <u>fabelliforme</u>	Ground cedar	FACU
GRASSES, SEDGES, AND RUSHES		
<u>Chasmanthium</u> <u>laxum</u>	Spangle grass	FAC



TABLE 3.2-5 VEGETATION IDENTIFIED IN THE WETLANDS SOUTH OF THE CFD, FORT MEADE

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
<b>TREES</b>		
<u>Acer rubrum</u>	Red maple	FAC
<u>Betula nigra</u>	River birch	FACW
<u>Caprinus caroliniana</u>	American hornbeam	FAC
<u>Ilex opaca</u>	American holly	FACU
<u>Liquidambar styraciflua</u>	Sweetgum	FAC
<u>Magnolia virginiana</u>	Sweetbay magnolia	FACW
<u>Platanus occidentalis</u>	American sycamore	FACW
<u>Populus deltoides</u>	Eastern cottonwood	FAC
<u>Quercus bicolor</u>	Swamp white oak	FACW
<b>SHRUBS</b>		
<u>Clethra alnifolia</u>	Pepperbush	FAC
<u>Leucothoe racemosa</u>	Fetter-bush	FACW
<u>Rosa palustris</u>	Swamp rose	OBL
<u>Sambucus canadensis</u>	American elder	FACW
<u>Vaccinium corymbosum</u>	Highbush blueberry	FACW
<b>VINES</b>		
<u>Mikania scandens</u>		
<u>Mitchella repens</u>	Partridge-berry	FACU
<u>Rhus radicans</u>	Poison ivy	FAC
<u>Smilax rotundifolia</u>	Greenbrier	FAC
<u>Vitis rotundifolia</u>	Muscadine grape	FAC
<b>FERNS AND FERN ALLIES</b>		
<u>Lycopodium fabelliforme</u>	Ground cedar	FACU
<u>Lycopodium inundation</u>	Bog clubmoss	OBL
<u>Osmunda cinnamomea</u>	Cinnamon fern	FACW
<u>Sphagnum</u> spp.	Peat moss	OBL

(a) Hydrophytic status follows Reed, P.B. Jr. (1988) The U.S. Fish and Wildlife National List of Plant Species that Occur in Wetlands unless indicated otherwise. Abbreviations:

OBL = Obligate (found in wetlands in more than 99% of all findings)  
 FACW = Faculative wetland (66-99%)  
 FAC = Faculative (33-66%)  
 FACU = Faculative upland (1-33%)  
 UP = Upland (<1%)

\* Hydrophytic status not reported; status presented is based on professional judgment and is supported by appropriate literature.

TABLE 3.2-5 (Cont.)

<u>Scientific Name</u>	<u>Common Name</u>	<u>Hydrophytic Status</u> <sup>(a)</sup>
GRASSES, SEDGES, AND RUSHES		
<u>Carex</u> spp.	Sedges	OBL
<u>Chasmanthium luxum</u>	Spangle grass	FAC
<u>Glyceria striata</u>	Fowl mannagrass	OBL
<u>Juncus effusus</u>	Soft rush	FACW
<u>Phalaris arundinacea</u>	Reed canary grass	FACW
<u>Phragmites australis</u>	Common reed	FACW
<u>Scirpus cyperinus</u>	Wool-grass	FACW
HERBS		
<u>Acorus calamus</u>	Sweetflag	OBL
<u>Boehmeria cylindrica</u>	False nettle	FACW
<u>Cardamine pensylvania</u>	Bittercress	OBL
<u>Elodea</u> sp.	Waterweed	OBL
<u>Epilobium coloratum</u>	Purple-leaf willow-weed	OBL
<u>Lemna minor</u>	Duckweed	OBL
<u>Ranunculus sepentrinnalis</u>	Swamp buttercup	OBL
<u>Symplocarpus foetidus</u>	Skunk cabbage	OBL
<u>Typha latifolia</u>	Broad-leaf cattail	OBL



TABLE 3.2-6 WILDLIFE PRESENCE OBSERVED AT THE REMEDIAL INVESTIGATION SITES, FORT MEADE

<u>Scientific Name</u>	<u>Common Name</u>
<b>BIRDS</b>	
<u>Philohela minor</u>	American woodcock <sup>(a)</sup>
<u>Aix sponsa</u>	Wood duck <sup>(a)</sup>
<u>Ardea herodias</u>	Great-blue heron <sup>(a)</sup>
<u>Anas platyrhynchos</u>	Mallard <sup>(a)</sup>
<u>Branta canadensis</u>	Canada goose <sup>(a)</sup>
<u>Larus argentatus</u>	Herring gull
<u>Corvus brachyrhynchos</u>	Common crow
<u>Cathartes aura</u>	Turkey vulture
<u>Butea jamaicensis</u>	Red-tailed hawk
<u>Falco sparverius</u>	American kestrel
<u>Colaptes auratus</u>	Common flicker
<u>Turdus migratorius</u>	American robin
<u>Sialia sialis</u>	Eastern bluebird
<b>MAMMALS</b>	
<u>Odocoileus virginianus</u>	White-tailed deer <sup>(a)</sup>
<u>Procyon lotor</u>	Raccoon
<u>Marmota monax</u>	Ground hog
<u>Vulpes vulpes</u>	Red fox <sup>(a)</sup>
<b>AMPHIBIANS</b>	
<u>Pseudacris triseriata feriarum</u>	Upland chorus frog
<u>Hyla crucifer crucifer</u>	Northern spring peeper
<b>REPTILES</b>	
<u>Coluber constrictor constrictor</u>	Northern black racer

(a) Species presence identified in the vicinity of the Clean Fill Dump.

### 3.3 NATURE OF CONTAMINATION

#### 3.3.1 Ground Water

Analytical results for ground-water samples collected at the CFD are summarized in Tables 3.3-1 through 3.3-4 and presented in Appendix H. Tetrachloroethene (PCE) (37.0  $\mu\text{g/L}$ ), trichloroethene (TCE) (5.40  $\mu\text{g/L}$ ), and 1,2-dichloroethene (total) (5.91  $\mu\text{g/L}$ ) were detected in the CFD-3S sample. The TCE level exceeds the current MCL (5  $\mu\text{g/L}$ ), and the PCE level exceeds the proposed MCL value of 5  $\mu\text{g/L}$ . There is no current final or proposed MCL value for 1,2-dichloroethene (total). In addition, chloroform, which has a final MCL of 100  $\mu\text{g/L}$  (total trihalomethanes), was detected in CFD-3D at a concentration of 4.10  $\mu\text{g/L}$ .

No SVOCs were detected, except for bis(2-ethylhexyl)phthalate (29.30  $\mu\text{g/L}$ ) in CFD-3D. The phthalate group of compounds are components of plastics materials and are common laboratory contaminants. The presence of this compound is probably not attributable to the CFD.

Low levels of eight pesticides were detected in four of the six ground-water samples collected at the CFD. One to three pesticides (4,4-DDT, aldrin, isodrin) were detected in the CFD-1, CFD-2, and CFD-3S samples, and six pesticides were detected in the CFD-3D sample. There are no regulatory criteria for any of the three pesticides detected in the aforementioned samples. Heptachlor and methoxychlor were two of the six pesticides detected in the CFD-3D sample and are the only pesticides of the six compounds detected in the ground-water samples for which an MCL exists. No regulatory criteria exist for any of the other four compounds. The heptachlor MCL is 0.40  $\mu\text{g/L}$  and the methoxychlor MCL is 40.0  $\mu\text{g/L}$ . The heptachlor (0.052  $\mu\text{g/L}$ ) and methoxychlor (0.23  $\mu\text{g/L}$ ) values detected in the CFD-3D sample are below the respective MCL values.

A review of the dissolved metals data indicates that none of the detected levels exceed the current MCLs. However, the zinc level in the CFD-4 sample (5,500  $\mu\text{g/L}$ ) exceeds the SMCL of 5,000  $\mu\text{g/L}$ .

Total arsenic and chromium were detected in the CFD-1 sample at 62.80 and 129.0  $\mu\text{g/L}$ , respectively. The MCLs for total arsenic and chromium are 50.0 and 100.0  $\mu\text{g/L}$ , respectively. The total lead values that exceed the Action Limit of 15  $\mu\text{g/L}$  included the samples from CFD-1 (103  $\mu\text{g/L}$ ), CFD-2 (152.0  $\mu\text{g/L}$ ), CFD-4 (71.10  $\mu\text{g/L}$ ), and CFD-5 (168.0  $\mu\text{g/L}$ ). All of the total metals values that exceed regulatory criteria are listed in Table 3.3-4.



The absence of any dissolved metals data that exceed the MCL indicates that there is no dissolved metal contamination in the ground water that is associated with metals leaching into solution from the CFD.

### 3.3.2 Surface Water and Stream Sediment

Surface water and stream sediment samples, SW/SS-8, were collected from the closest perennial stream to the CFD. This stream is an unnamed tributary to the Little Patuxent River and is located approximately 1,200 ft south of the CFD (Figure 3.2-1). Analytical results for this sample are summarized in Tables 3.3-5 and 3.3-6, and are presented in Appendix H.

No VOCs or SVOCs were detected in either the surface water or stream sediment sample.

Low levels of pesticides were detected in the stream sediment sample, SS-8. The pesticides detected included 4,4'-DDT and its degradation by-products 4,4'-DDE and 4,4'-DDD.

Low levels of pesticides were also detected in the surface water sample, SW-8. 4,4'-DDE, delta-BHC, and isodrin were detected at concentrations of 0.007, 0.008, and 0.006  $\mu\text{g/L}$ , respectively. There are no surface water drinking quality criteria for isodrin. However, the acute surface water quality criterion for 4,4'-DDE is 1.1  $\mu\text{g/L}$  and 2.5  $\mu\text{g/L}$  for dieldrin. Thus, the detected values for these parameters are less than the acute surface water drinking quality criteria.

The metals values associated with SS-8 are within published background values. Other than copper, the metals detected in SW-8 are within the acute surface water quality criteria. Copper, which was detected at a concentration of 18.8  $\mu\text{g/L}$ , slightly exceeds the acute surface water criteria for copper, which is 18.0  $\mu\text{g/L}$ .

### 3.3.3 Contaminant Assessment

The analytical results indicate that the primary environmental concerns at the site are PCE (37.0  $\mu\text{g/L}$ ) and TCE (5.40  $\mu\text{g/L}$ ) in the ground-water sample from CFD-3S. These compounds were not detected in the sample collected from CFD-3D (total depth = 70 ft), the deep well located next to CFD-3S (total depth = 9.5 ft). The upward vertical gradient exhibited by the higher water level in CFD-3D compared to CFD-3S indicates that this is a ground-water discharge area which will inhibit downward vertical migration of contaminants.

PCE and TCE are part of the chlorinated ethene chemical family group. Vinyl chloride, cis-1,2-dichloroethene, 1,1-dichloroethene, and trans-1,2-dichloroethene are also included in this chemical group, but were not detected. These compounds can be transformed by a reductive dehalogenation process which involves the rupturing of one carbon-halogen bond in solvents to yield a compound with one less chlorine than its precursor. A general sequence of dehalogenation of the ethene compounds is shown in Figure 3.3-1. The transformation of these compounds may also occur through chemical (hydrolysis and hydration) and biological processes. The chemical data indicate that TCE is probably a degradation product of PCE.

CFD-3S is located immediately downgradient of the CFD, and the initial phases of contaminant migration were likely driven in part by precipitation flushing through the contaminated mass and transporting solvents mixed with rain water vertically downward into the saturated zone. The transport processes affecting contaminant migration in the saturated zone include the following:

Advection--Process by which solutes are transported by the bulk motion of flowing ground water.

Dispersion--Process that acts to spread contaminants through mechanical mixing and molecular diffusion.

Sorption-Retardation--Interaction of contaminants with the aquifer solids through partitioning, ion exchange, and adsorption resulting in the distribution of contaminants between the aqueous phase and the aqueous solids.

The interaction of these processes with the concentration and strength of the contaminant, coupled with the chemical soil reactions and ground-water flow regime, combine to form a mechanism of transport for contaminant plumes. The advection process is primarily controlled by the hydraulic gradient and porosity of the ground-water flow system.

The dispersion process is related to variations in ground-water velocity and based on the consistency of the subsurface material. This process is believed to have a minimal effect on migration. The sorption and retardation factors are functions of the contaminant affinity for soil particles and the amount of solid organic matter in the aquifer.

In general, the more insoluble a contaminant, and the higher carbon content of the aquifer, the higher the retardation factor will be. A value that is generally used to express the relative rate at which a specific constituent



moves is called the retardation factor. PCE at its solubility limit of 200 mg/L (Schwille 1988) has a retardation factor of 5.0, whereas TCE at its solubility limit of 1,100 mg/L (Schwille 1988) has a retardation factor of 2.5. This means that PCE migrates at approximately one-fifth and TCE at less than one-half the velocity of ground water at this concentration.

The levels of PCE (37  $\mu\text{g/L}$ ) and TCE (5.4  $\mu\text{g/L}$ ) detected in the CFD-3S sample are significantly lower than their solubility limits. The retardation factor is probably closer to one for the low concentrations at the site, which would indicate that the PCE and TCE migrate at roughly the calculated average ground-water velocity of approximately 84 ft/year.

#### 3.3.4 Aquatic Resources Survey Results

##### Benthic Invertebrate Sampling Results

Only one station (LP4) is located in the vicinity of the CFD (Figure 2.2-8). Station LP4 is located on the Little Patuxent River adjacent to the dump and has habitat conditions sufficient to support a healthy benthic community. A list of species collected from Station LP4 is presented in Table 3.3-7. A total of 21 unique taxa were collected from LP4. Diptera, primarily Chironomidae larvae (midges), and Oligochaeta (worms), were the most common taxa (12) of the (21) combined taxa at this station. Trichoptera larvae (caddisflies) and Ephemeroptera (mayflies) were found at this station, but in very low numbers (2 and 3, respectively).

##### Physicochemical

Results of the physicochemical parameters are presented in Table 3.3-8. These parameters were measured concurrent with the benthic invertebrate sampling at Station LP4. Of the four parameters (dissolved oxygen, temperature, pH, and conductivity), no outliers were detected.

##### Metrics

A detailed description of the metrics and the metric analysis approach can be found in Appendix A.9. Values for the eight metrics for the stations near the CFD site are given in Appendix A.9. The total metric score for Station LP4 based on rank among all stations is 38.5. This score (38.5) is the lowest calculated for any station on the Little Patuxent. Allowing for approximately 20 percent deviation from the maximum score (63.5) for natural variability, Station LP4 may be classified as slightly impaired for both total metrics and the selected three metrics. This analysis is based on the rapid bioassessment protocol technique in Plafkin et al. 1989.

## Habitat Assessment

A summary of habitat quality at Station LP4 can be found in Table 3.3-9. The various habitat parameters are weighted to emphasize the most biologically significant parameters. Station LP4 lies within the confidence intervals of the graphs presented in Figures 3.3-2 and 3.3-3. However, when station LP4 is compared to other stations on the Little Patuxent, a decrease in the total metric score is evident, suggesting some stress to the benthic community at this station (Figure 3.3-4).

## Assessment

To characterize the area near the CFD, other stations upstream of LP4 must be compared to Station LP4 to determine if stress is evident. While Station LP4 may exhibit a lower quality benthic community when compared to stations upstream on the Little Patuxent, this station is not considered different from the other stations in the Fort Meade confines. As a result, it appears that the CFD does not result in significant stress to the invertebrate community at Station LP4.

## Fisheries Investigation

### Description of Sampling Stations

Station LP4 was located on the Little Patuxent River adjacent to a wetland that drains the CFD (Figure 2.2-8). The primary outlet of the wetland area enters the Little Patuxent River downstream of Station LP4 outside the Fort Meade military reservation boundary. This station was characterized by relatively clean riffle areas composed of gravel and cobble substrates and sandy-bottomed runs and run/pool habitat. Undercut banks and instream woody debris were common over the sampled reach. Habitat sampled for fish included approximately 36, 71, and 100 m of riffles, runs, and run/pool habitat, respectively.

### Results of Fish Investigations

A total of 106 fish representing 13 species and 6 families were collected from Station LP4 near the CFD (Table 3.3-10). The minnow family Cyprinidae, and the sunfish family Centrarchidae, dominated the catch with five and four species collected, respectively. The dominance of minnows and sunfishes is typical in transitional areas between Piedmont and Coastal Plain physiographic provinces in Maryland (Lee et al. 1976). The four most common species represented more than 70 percent of the total catch and included three minnows--satinfin shiner ( $n = 37$ ), swallowtail shiner ( $n = 17$ ), and river



chub (n = 10)--and one darter--tessellated darter (n = 13). All 13 species collected at LP4 had been previously reported to occur in the Patuxent River drainage (PWRC 1979; MDNR 1985).

The total number of species collected at Station LP4 (n = 13) was similar to other stations sampled on the Little Patuxent River (Appendix A.9); however, some differences in species composition were noted. Sunfish species were less common at Station LP4 (11.3 percent) than at LP1 (75.0 percent), LP2 (26.2 percent), and LP3 (28.8 percent) (Appendix A). This difference appears to be related more to differences in habitat at each site than to differences in water quality. In general, sites with a greater proportion of sunfish collected (LP1, LP2, LP3) had more extensive areas of pool habitat.

Fish collected at Station LP4 appeared to be in good health. Based on observations, there were no incidences of parasitism, fin erosion, or the presence of any other external anomalies noted (Appendix A.9).

There was no evidence from the fish survey suggesting that an impaired fish community existed at Station LP4 despite the proximity of Station LP4 to the CFD. Total number of species and species composition of fishes collected at Station LP4 compared similarly to other biological stations (LP1, LP2, LP3) sampled on the Little Patuxent River (Appendix A) and any observed differences appeared to be habitat-related. Incidence of parasitism and other external abnormalities was virtually nonexistent for fishes examined at Station LP4. Furthermore, potential water quality affects associated with runoff from the CFD may be lessened by the wetlands area downgradient of the CFD prior to discharge into the Little Patuxent River.

**Figure 3.3-1. BIODEGRADATION RATES FOR CHLOROETHENE COMPOUNDS  
IN A MUCK-WATER SAMPLE**

<u>Compound</u>	<u>Molecular Structure</u>	<u>Half-Life in Days (200 µg cpd)</u>
tetrachloroethene	$  \begin{array}{c}  \text{CL} \quad \text{CL} \\  \diagdown \quad \diagup \\  \text{C}=\text{C} \\  \diagup \quad \diagdown \\  \text{CL} \quad \text{CL}  \end{array}  $	34
trichloroethene	$  \begin{array}{c}  \text{H} \quad \text{CL} \\  \diagdown \quad \diagup \\  \text{C}=\text{C} \\  \diagup \quad \diagdown \\  \text{CL} \quad \text{CL}  \end{array}  $	43
cis 1,2-dichloroethene	$  \begin{array}{c}  \text{H} \quad \text{H} \\  \diagdown \quad \diagup \\  \text{C}=\text{C} \\  \diagup \quad \diagdown \\  \text{CL} \quad \text{CL}  \end{array}  $	long
trans 1,2-dichloroethene	$  \begin{array}{c}  \text{H} \quad \text{CL} \\  \diagdown \quad \diagup \\  \text{C}=\text{C} \\  \diagup \quad \diagdown \\  \text{CL} \quad \text{H}  \end{array}  $	long
1,1-dichloroethene	$  \begin{array}{c}  \text{H} \quad \text{CL} \\  \diagdown \quad \diagup \\  \text{C}=\text{C} \\  \diagup \quad \diagdown \\  \text{H} \quad \text{CL}  \end{array}  $	53
vinyl chloride	$  \begin{array}{c}  \text{H} \quad \text{H} \\  \diagdown \quad \diagup \\  \text{C}=\text{C} \\  \diagup \quad \diagdown \\  \text{H} \quad \text{CL}  \end{array}  $	long

Source: Parsons, F.Z., et al., AWWA Journal, FEB 1984.



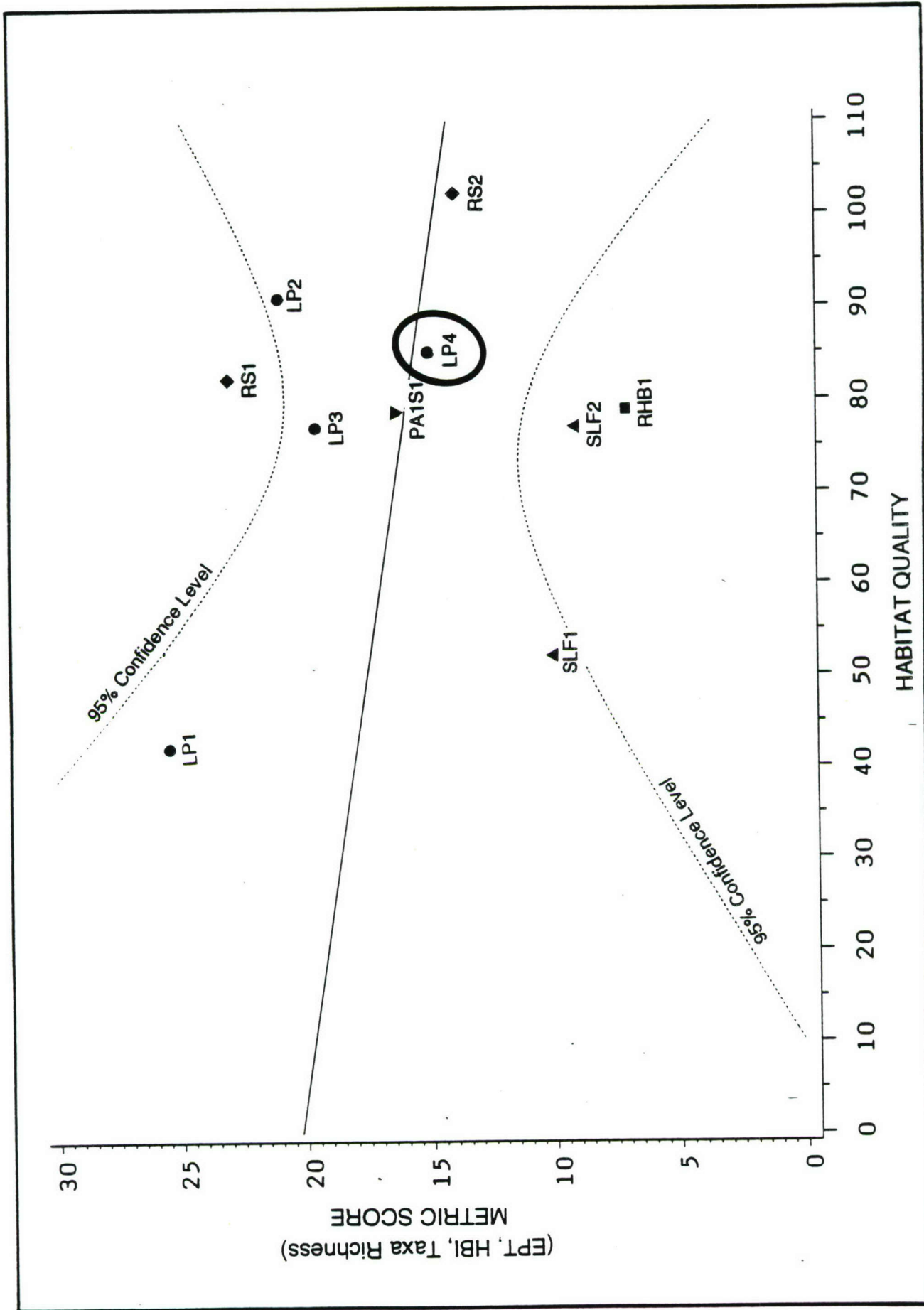


Figure 3.3-2. Benthic assessment of biological stations at Fort Meade comparing the relationship of habitat quality to the total number of the three metrics (EPT, HBI, Taxa Richness).

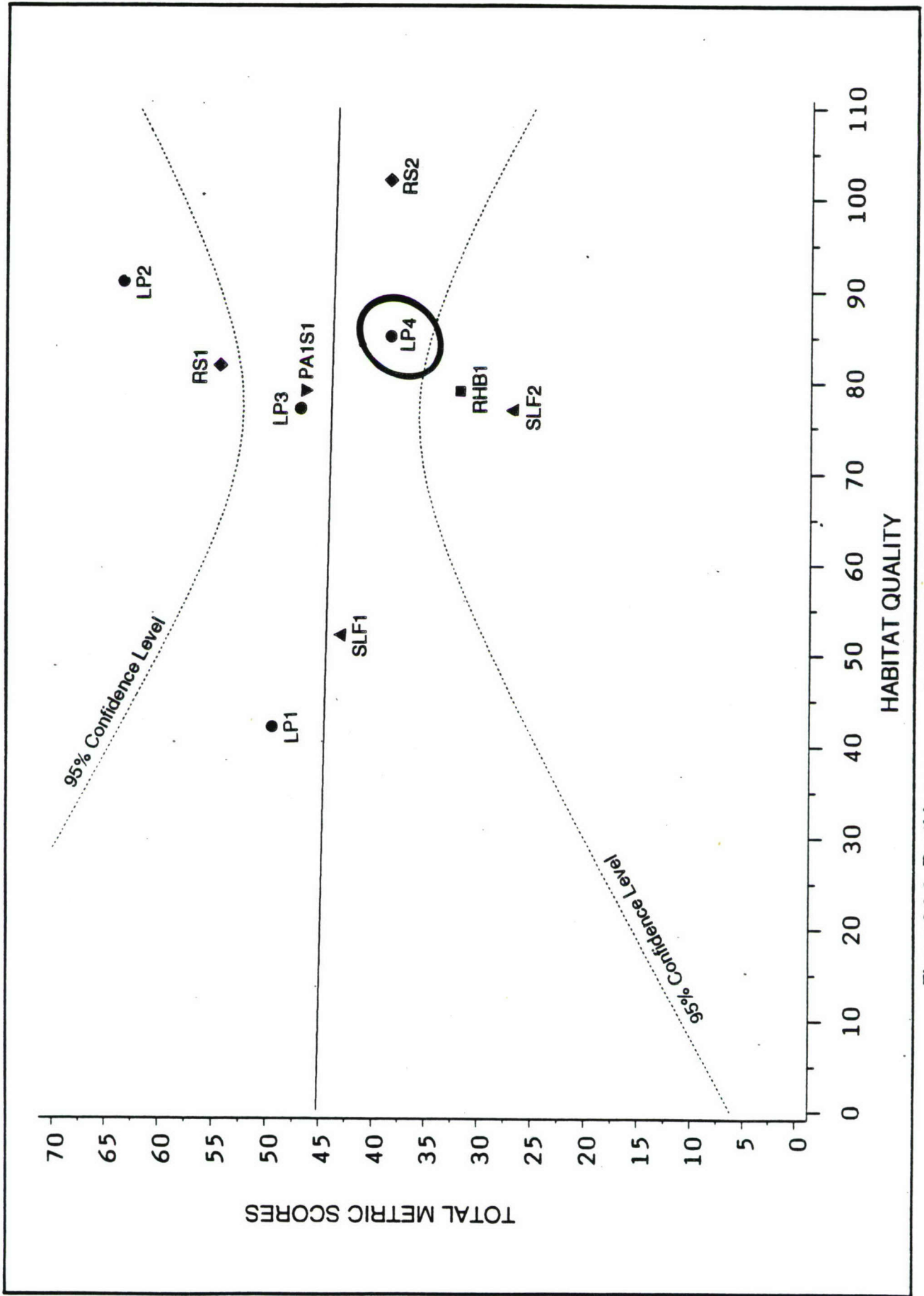


Figure 3.3-3. Benthic assessment of biological stations at Fort Meade comparing the relationship of habitat quality to all metric scores.



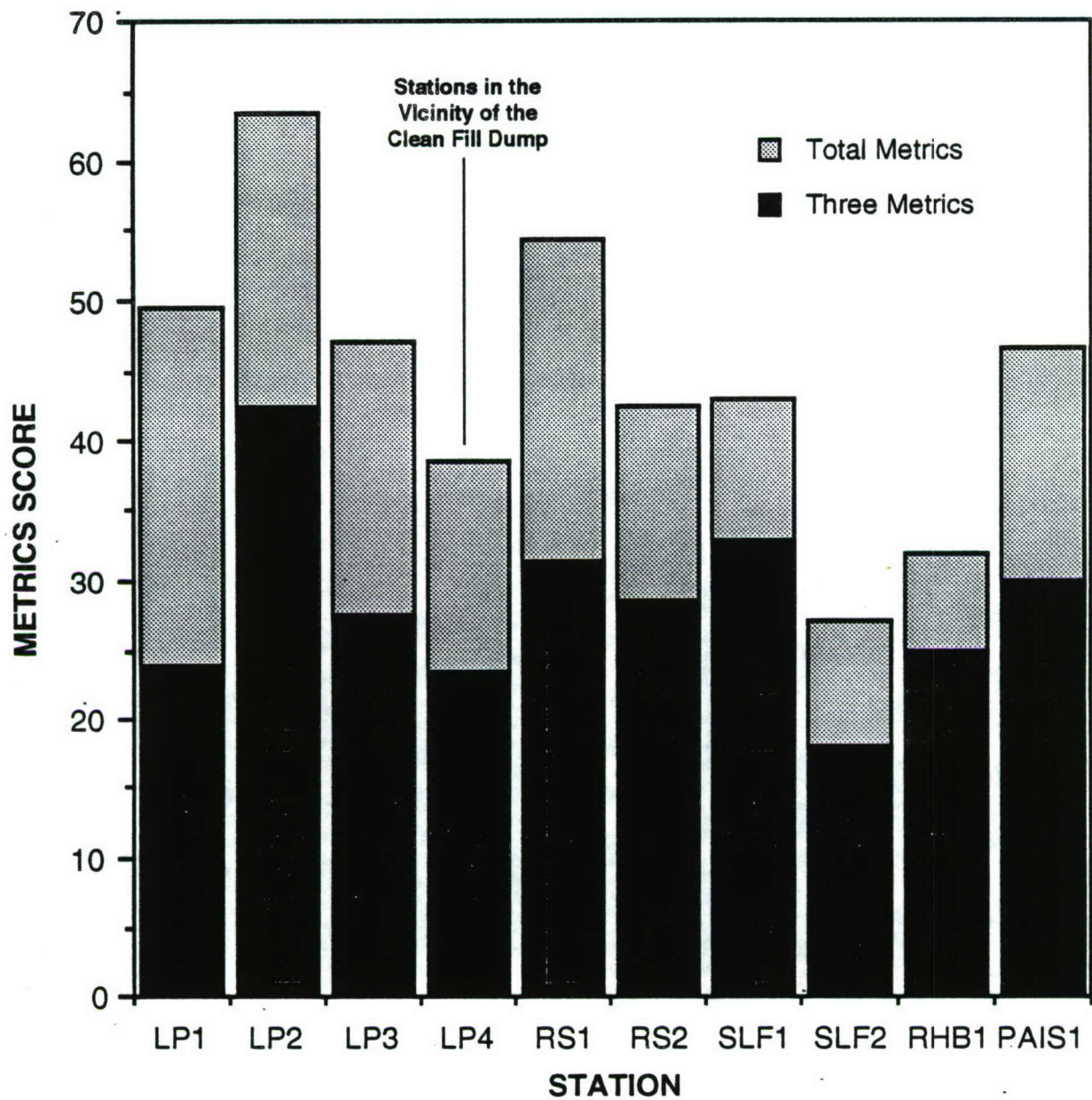


Figure 3.3-4. Metric scores based on rank for sampling stations in the Base Closure Parcel, Fort Meade. (Individual metrics results are provided in Appendix F.)

TABLE 3.3-1 CLEAN FILL DUMP GROUND-WATER ORGANIC DATA

<u>Parameter</u>	<u>MCL</u>		<u>Sample ID</u>				
	<u>Final</u>	<u>Proposed</u>	<u>CFD-1</u>	<u>CFD-2</u>	<u>CFD-3S</u>	<u>CFD-3D</u>	<u>CFD-4</u> <u>CFD-5</u>
<b>VOLATILES</b>			ND	ND			ND ND
1,2-Dichloroethene (total)	-----	-----			5.91		
Chloroform	100.0	-----				4.10	
Tetrachloroethene	-----	5.0			37.00		
Trichloroethene	5.0	-----			5.40		
<b>SEMIVOLATILES</b>			ND	ND	ND		ND ND
Bis(2-ethylhexyl)phthalate	-----	-----				29.30	
<b>PESTICIDES</b>							ND ND
4,4'-DDT	-----	-----	0.009				
Aldrin	-----	-----	0.011			0.010	
Alpha-BHC	-----	-----				0.004	
Delta-BHC	-----	-----		0.006	0.007	0.011	
Dieldrin	-----	-----				0.064	
Heptachlor	0.40	-----				0.052	
Isodrin	-----	-----	0.003	0.006			
Methoxychlor	40.0	-----				0.23	

Units:  $\mu\text{g/L}$ .

---- No MCL exists for this compound.

ND Not detected.



TABLE 3.3-2 CLEAN FILL DUMP GROUND-WATER TOTAL METALS DATA

Parameter	MCL	Sample ID				
		CFD-1	CFD-2	CFD-3S	CFD-3D	CFD-4
Aluminum	----	15,100	1,510.0	<112.0	614.0	7,080.0
Antimony	----	<60.00	<60.00	<60.00	<60.00	<60.00
Arsenic	50.0	62.80	29.50	<2.35	<2.35	6.76
Barium	1,000	214.0	42.40	16.80	13.70	94.40
Beryllium	----	4.38	<1.12	<1.12	<1.12	48.50
Cadmium	5.00	<6.78	<6.78	<6.78	<6.78	<6.78
Calcium	----	11,900	2,440.0	1,750.0	4,030.0	3,790.0
Chromium	100	129.0	<16.80	<16.80	<16.80	24.00
Cobalt	----	<25.00	<25.00	<25.00	<25.00	46.30
Copper	1,300	143.0	29.70	<18.80	<18.80	35.50
Iron	----	66,400	8,230.0	150.0	931.0	7,860.0
Lead	15.0	103.0	152.0	<4.47	<4.47	71.10
Magnesium	----	1,560.0	1,770.0	1,720.0	576.0	4,420.0
Manganese	----	74.40	96.00	53.10	23.70	122.0
Mercury	2.00	0.16	<0.100	<0.100	<0.100	<0.100
Nickel	----	48.90	39.90	<32.10	<32.10	86.00
Potassium	----	5,580.0	<1,240.0	3,580.0	<1,240.0	2,300.0
Selenium	50.0	<2.53	<2.53	<2.53	<2.53	<2.53
Silver	50.0	1.01	0.42	<0.33	<0.33	<0.33
Sodium	----	3,910.0	2,800.0	4,880.0	1,840.0	9,150.0
Thallium	----	<125.0	<125.0	<125.0	<125.0	<125.0
Vanadium	----	204.0	<27.60	<27.60	<27.60	72.80
Zinc	----	183.0	10,000	2,810.0	98.20	12,000
						11,000

Units:  $\mu\text{g/L}$ .

----- No MCL exists for this compound.

TABLE 3.3-3 CLEAN FILL DUMP GROUND-WATER DISSOLVED METALS DATA

Parameter	MCL	Sample ID					
		CFD-1	CFD-2	CFD-3S	CFD-3D	CFD-4	CFD-5
Aluminum	----	<112.0	<112.0	<112.0	<112.0	389.0	277.0
Antimony	----	<60.00	<60.00	<60.00	<60.00	<60.00	<60.00
Arsenic	50.0	<2.35	<2.35	<2.35	<2.35	<2.35	37.40
Barium	1,000	17.40	13.30	12.40	3.11	38.70	16.30
Beryllium	----	<1.12	<1.12	<1.12	<1.12	<1.12	<1.12
Cadmium	5.00	<6.78	<6.78	<6.78	<6.78	<6.78	<6.78
Calcium	----	4,510.0	1,960.0	1,880.0	3,460.0	3,530.0	71,700
Chromium	100	<16.80	<16.80	<16.80	<16.80	<16.80	<16.80
Cobalt	----	<25.00	<25.00	<25.00	<25.00	33.70	<25.00
Copper	1,300	<18.80	<18.80	<18.80	<18.80	<18.80	<18.80
Iron	----	251.0	1,370.0	255.0	<77.50	613.0	17,400
Lead	15.0	<4.47	7.48	<4.47	<4.47	6.41	<4.47
Magnesium	----	648.0	1,380.0	1,830.0	514.0	3,680.0	8,260.0
Manganese	----	18.30	63.50	60.80	14.80	104.0	166.0
Mercury	2.00	<0.100	<0.100	<0.100	<0.100	<0.100	
<0.100							
Nickel	----	<32.10	<32.10	<32.10	<32.10	63.50	<32.10
Potassium	----	1,580.0	<1,240.0	4,010.0	<1,240.0	2,230.0	4,410.0
Selenium	50.0	<2.53	<2.53	<2.53	<2.53	<2.53	<2.53
Silver	50.0	<0.33	<0.33	<0.33	<0.33	<0.33	0.99
Sodium	----	3,570.0	2,420.0	5,660.0	1,930.0	9,300.0	13,800
Thallium	----	<125.0	<125.0	<125.0	<125.0	<125.0	<125.0
Vanadium	----	<27.60	<27.60	<27.60	<27.60	<27.60	<27.60
Zinc	----	34.30	2,000.0	3,860.0	50.70	5,500.0	826.0

Units: µg/L.

---- No MCL exists for this compound.



TABLE 3.3-4 CFD GROUND-WATER TOTAL METALS DATA THAT EXCEED MCL CRITERIA

<u>Parameter</u>	<u>MCL</u>	<u>AL</u>	<u>CFD-1</u>	<u>Sample ID</u>		
				<u>CFD-2</u>	<u>CFD-4</u>	<u>CFD-5</u>
TOTAL METALS						
Arsenic	50.0		62.80			
Chromium	100		129.0			
Lead		15.0	103.0	152.0	71.10	168.0

---

Units:  $\mu\text{g/L}$ .

AL: Action level.

TABLE 3.3-5 CLEAN FILL DUMP SURFACE WATER AND SEDIMENT ORGANIC DATA

<u>Sample ID</u>	<u>SS-8</u>	<u>SW-8</u>
VOLATILES	ND	ND
SEMIVOLATILES	ND	ND
PESTICIDES		
4,4'-DDD	0.019	
4,4'-DDE	0.012	0.007
4,4'-DDT	0.025	
Aroclor-1260	0.16	
Delta-BHC		0.008
Dieldrin	0.007	
Endosulfan I	0.006	
Endosulfan II	0.002	
Heptachlor	0.006	
Heptachlor epoxide	0.006	
Isodrin		0.006
GENERAL ORGANIC		
Total organic carbon	78,000	

Units:  $\mu\text{g/g}$  (Sediments);  $\mu\text{g/L}$  (Surface Water).  
ND Not detected.



TABLE 3.3-6 CLEAN FILL DUMP SURFACE WATER AND SURFACE SEDIMENT TOTAL METALS DATA

<u>Parameter</u>	<u>Sample ID</u>	
	<u>SW-8</u>	<u>SS-8</u>
Aluminum	<112	34,600
Antimony	<60.0	<19.6
Arsenic	<2.35	15.6
Barium	<2.82	117
Beryllium	<1.12	1.86
Cadmium	<6.78	<1.20
Calcium	3,070	6,000
Chromium	<16.8	39.0
Cobalt	<25.0	14.3
Copper	18.8	27.4
Iron	682	57,100
Lead	<4.47	32.8
Magnesium	623	3,200
Manganese	194	207
Mercury	<0.1	<0.05
Nickel	32.1	22.6
Potassium	1,240	2,410
Selenium	<2.53	<0.449
Silver	<0.33	0.19
Sodium	2,200	178
Thallium	<125.0	<34.3
Vanadium	<27.6	58.6
Zinc	<18.0	117

Units:  $\mu\text{g/L}$ .

TABLE 3.3-7 ABUNDANCE OF BENTHIC MACROINVERTEBRATES COLLECTED FROM  
BIOLOGICAL STATIONS, REMEDIAL INVESTIGATION SITES, FORT MEADE,  
20 MARCH - 4 APRIL 1991

	*LP4	Stations		RHB1
		SLF1	SLF2	
Tricladida				8
Nematoda		1		
Lumbriculidae		1		
<u>Nais behningi</u>	2			
<u>N. bretscheri</u>	3			
<u>N. communis</u>	3			
<u>N. pardalis</u>	5			1
<u>N. variabilis</u>	1			
Imm. tub. w/o cap. chaetae	5	1	2	1
<u>Limnodrilus hoffmeisteri</u>		6		
<u>Hyaella azteca</u>		1		
<u>Ephemerella</u> N.	1			
<u>Stenonema modestum</u> N.	2			
<u>Calopteryx</u> N.		1		
<u>Ischnura</u> N.			1	
<u>Cordulegaster</u> N.		1		
Nemouridae N.			13	
<u>Corydalis cornutus</u> L.	1			
<u>Helichus</u> L.	1			
Dytiscidae L.			1	
<u>Macronychus glabratus</u> L.	1			
<u>Berosus</u> L.	1			
Hydropsychidae L.				7
<u>Cheumatopsyche</u> L.		9	3	6
<u>Hydropsyche</u> L.	2			
<u>H. betteni</u> L.		5	1	46
<u>Ironoquia</u> L.		1		
Empididae L.	1			
<u>Hemerodromia</u> L.				3
<u>Chaoborus</u> L.		1		
Chironomidae P.	13	3		
<u>Cryptochironomus</u> L.		1		
<u>Polypedilum convictum</u> L.		2		49
<u>P. illinoense</u> L.	1			
<u>P. scalaenum</u> L.		2		
<u>Pseudochironomus</u> L.				3
<u>Rheotanytarsus</u> L.				1
<u>Tanytarsus</u> L.				8
Diaesinae L.	26			
<u>Cricotopus</u> L.			1	

Note: Total number of organisms is based on a 100-organism subsample.

\* Biological sampling station in the vicinity of the Clean Fill Dump.



TABLE 3.3-7 (Cont.)

	<u>*LP4</u>	<u>Stations</u>		<u>RHB1</u>
		<u>SLF1</u>	<u>SLF2</u>	
<u>C. bicinctus</u> L.	2	7	7	3
<u>C. tremulus</u> L.	18	21	9	10
<u>Orthocladius</u> L.	4	3	5	
<u>Symposiocladius</u> L.	1			
<u>Thienemannimyia</u> series L.		5	1	1
<u>Simuliidae</u> P.	1		6	7
<u>Prosimulium</u> L.	1			
<u>Simulium</u> L.			65	19
<u>Tabanidae</u> L.		3		
<u>Tipulidae</u> L.		1		
<u>Antocha</u> L.		1		
<u>Tipula</u> L.		1		1
<u>Lymnaeidae</u>		1		
<u>Physella</u>		2	7	1
<u>Pisidium</u>				1
Total Number of Taxa	21	23	12	17
Total Number of Organisms	96	81	122	178

TABLE 3.3-8

PHYSICOCHEMICAL PARAMETERS MEASURED AT BIOLOGICAL STATIONS,  
REMEDIAL INVESTIGATION SITES, FORT MEADE, 20 MARCH - 4 APRIL  
1991

<u>Station</u>	<u>Temperature (°C)</u>	<u>pH</u>	<u>Dissolved Oxygen (mg/L)</u>	<u>Conductivity (μmhos/cm)</u>
*LP4	10.9	8.1	10.0	293
SLF1	11.9	7.8	10.4	601
SLF2	12.1	7.9	9.9	494
RHB1	9.4	7.8	10.8	273

\* Station located near the Clean Fill Dump.



TABLE 3.3-9 SUMMARY OF THE HABITAT QUALITY AT BIOLOGICAL STATIONS,  
REMEDIAL INVESTIGATION SITES, FORT MEADE, 20 MARCH - 4 APRIL  
1991

<u>Habitat Parameters</u>	<u>Station</u>			
	<u>LP4<sup>(a)</sup></u>	<u>SLF1</u>	<u>SLF2</u>	<u>RHB1</u>
Primary Parameters				
Substrate	15	5	13	8
Embeddedness	10	6	10	8
Velocity/Depth	16	9	15	16
Secondary Parameters				
Channel Alteration	10	3	7	6
Scouring/Deposition	7	5	6	6
Run/Bend	12	5	7	11
Tertiary Parameters				
Bank Stability	5	5	5	7
Bank Vegetation	4	7	7	9
Streamside Cover	6	7	7	8
Total Score	85	52	77	79

(a) Station located near the Clean Fill Dump.

TABLE 3.3-10 ABUNDANCE OF FISHES COLLECTED FROM THE LITTLE PATUXENT RIVER  
IN THE VICINITY OF THE CFD, FORT MEADE, 22 MARCH 1991

<u>Species</u>	<u>Station</u> <u>LP4</u>
Sea lamprey	1
American eel	9
River chub	10
Satinfin shiner	37
Swallowtail shiner	17
Longnose dace	1
Fallfish	4
Banded killifish	2
Bluespotted sunfish	2
Redbreast sunfish	7
Pumpkinseed	1
Bluegill	2
Tessellated darter	13
Total specimens	106
Total species	13



### 3.4 RISK ASSESSMENT FOR THE CLEAN FILL DUMP

#### 3.4.1 Introduction

This risk assessment evaluates the Clean Fill Dump (CFD) site, which encompasses approximately 15 acres located on the eastern edge of FGGM. This assessment is an evaluation of the potential effects on human health posed by exposure to releases from the CFD site. The risk assessment considered releases to the ground water, surface water, and sediment from the CFD. This assessment followed the same procedures as those used for the ASL. Detail given in Section 2.5 for the ASL is not repeated here.

##### 3.4.1.1 Site Background for Risk Assessment

The CFD site is located in a lowland area along Boundary Road and was used from 1972 to 1985 for the disposal of construction wastes and debris such as lumber, concrete, rock, tires, old appliances, and fill dirt. The Enhanced Preliminary Assessment (U.S. DOE 1989) reported that excluded types of waste may also have been disposed at the CFD.

##### 3.4.1.2 Human Health Evaluation

Risk was quantified using data from ground water sampled in the vicinity of the CFD. Ground-water samples were collected from five downgradient wells (CFD-2, CFD-3S, CFD-3D, CFD-4, and CFD-5) and one upgradient (CFD-1). For the purposes of this risk assessment, all ground-water data were considered representative of the water-table aquifer.

In addition to ground water, one surface water and one stream sediment sample were collected approximately 1,200 ft south of the CFD at the nearest surface water.

#### 3.4.2 Identification of Chemicals of Potential Concern

In order to identify contaminants of potential concern at the site, detailed chemical analysis of samples was required. Data collection procedures are described in Section 2.3 of this report. Environmental samples were collected in the field by EA and sent to EA Laboratories or DataChem Laboratories for analysis in accordance with the USATHAMA Quality Assurance Program. Analytical data were submitted to the Installation Restoration Data Management Information System (IRDMIS) where they were retrieved by EA for use in this risk assessment once they became Level 3 data.

Contamination of the ground and surface water on or surrounding the CFD site was suspected to occur primarily due to releases from the waste materials deposited at the site. Chemicals of potential concern in the ground water and surface water and sediment were identified using the data management conventions similar to those used for the ASL.

Chemicals of potential concern are defined as chemicals detected during sample analysis and are considered likely to have originated from site-related activities. All compounds that were present at levels above measured background and that were not considered essential human nutrients were included in this risk assessment.

The following guidelines were used in managing the analytical data for the chemicals identified as being of potential concern:

- Analytical chemical data were summarized by calculating both an arithmetic mean for each compound as the measure of the average concentration of that compound, and by calculating a reasonable maximum exposure (RME) concentration which corresponds to the 95th percentile upper confidence limit on the mean for each compound. The RME value represents the upper bound value on the possible range of compound concentrations. There is only a 5 percent chance that a value greater than this one will occur.
- In calculating the arithmetic mean, one-half the Certified Reporting Limit (CRL) was used as the value for the samples in which a compound was not detected.

In addition to these general guidelines, media-specific sampling and data management issues are discussed in the following sections.

#### 3.4.2.1 Surface Water/Sediment Data

One surface sediment sample was collected in the vicinity of the CFD approximately 1,200 ft south of the CFD. Most metals and nine pesticides were detected. There were no volatile organic or semivolatile organic compounds detected in the sediment. These sediment data are listed in Tables 3.3-5 and 3.3-6.

A single surface water sample collected at the same location as the sediment sample showed the presence of only three metals (copper, manganese, and nickel) in addition to the essential nutrient metals which were eliminated from consideration in this risk assessment. Three pesticides were detected



(4,4'-DDE, delta-BHC, and isodrin). There were no volatile or semivolatile organic compounds detected. Sediment data from the CFD are also shown in Tables 3.3-5 and 3.3-6.

#### 3.4.2.2 CFD Ground Water Data

The ground-water data are summarized in Table 3.4-1. Three volatile organic compounds, 1,2-dichloroethene, tetrachloroethene, and trichloroethene, were detected in the sample collected from CFD-3S. Chloroform was detected in the CFD-3D sample but was eliminated from further consideration on the basis of its detection in the field blank. Of the 19 metals detected, calcium, iron, magnesium, potassium, and sodium were eliminated on the basis that they are essential human nutrients, and aluminum, barium, copper, nickel, silver, and vanadium were not considered further because they were present at average levels below their respective background concentrations in CFD-1. The remaining metals (arsenic, beryllium, chromium, cobalt, lead, manganese, mercury, and zinc) were included in this risk assessment. Average and reasonable maximum exposure concentrations for these metals plus the volatile and semivolatile organic compounds and pesticides detected in ground-water samples are given in Table 3.4-1.

#### 3.4.3 Exposure Assessment

The CFD is an unlined inactive facility located in a lowland area. As for the ASL, recreational use of this area has been reported. Possible exposure pathways were considered for each of the types of samples collected in the field assessment of the site. Exposure pathways that were considered for this assessment are the same as those considered for the ASL. These pathways are discussed in Section 2.5.3 and summarized in Table 2.5-3.

##### 3.4.3.1 Exposures Under Current Land Use Conditions

While all exposure pathways listed in Table 2.5-3 were considered, there were no pathways selected for an assessment of risk given the current land uses of the CFD. There are no significant exposures to ground water, surface water, sediment, or air resulting from present day use of the CFD. Because the CFD is well covered by clean fill and is heavily vegetated, there is no exposure to air emissions.

##### 3.4.3.2 Exposures Under Future Land Use Conditions

This site has been transferred to the Fish and Wildlife Service as an extension of the Patuxent Wildlife Research Center. It is possible that with

the release of military control of the area there will be increased public access to the sites.

#### Ground Water

The potential for future residents to install drinking water wells onsite or directly adjacent to the site is highly unlikely. Nevertheless, the ingestion of ground water onsite by future residents was evaluated. The risk due to this exposure pathway, in the absence of any remediation, was quantified for this assessment.

#### Surface Water/Sediment

For there to be a significant risk from contaminants in surface water or sediment, there has to be substantial exposure and/or high levels of contaminants in the surface water or sediment. Risks are minimized by factors such as limited duration of exposure, limited chance for incidental ingestion, and low observed concentrations.

In the case of surface water near the CFD, even in the unlikely event of heavy exposure, e.g., long-term swimming, risk resulting from the low observed concentrations of compounds would be minimal. Therefore, as for sediment, no quantification of risk was carried out for pathways involving surface water.

#### 3.4.3.3 Chemical Intake

Quantitative assessments of potential risks to human health associated with the exposure scenarios considered for the CFD were made in the same manner as those for the ASL (Section 2.5.3.3.). The exposure point concentrations were first converted to intakes, expressed as the amount of a substance taken into the body per unit body weight per unit time (mg/kg·day), and were averaged over a lifetime for carcinogens and over the exposure period for noncarcinogens.

Two levels of exposure were estimated providing estimates for an average exposure calculated using average exposure assumptions and an RME-calculated using more intensive exposure assumptions. Exposure assumptions used here were the same as those used in the assessment of the ASL (Table 2.5-4).

#### Future Ingestion of Ground Water by Hypothetical Residents

It is unlikely that anyone will be drinking ground water from the CFD site in the foreseeable future. However, since contaminants were found in the ground



water onsite and ground water is a potential pathway for human exposure, intakes were estimated for ingestion of ground water.

Exposure caused by ground-water ingestion was determined for both average and RME scenarios. This was accomplished by calculating the average and maximum intake of ground water using the same equation and assumptions that were used in the exposure assessment for the ASL (Section 2.5.3.3).

#### Intake From Ingestion of Ground Water

Data collected from five wells completed in the water-table aquifer in the CFD area were used to calculate chronic daily intakes for noncarcinogenic and carcinogenic compounds. Average and reasonable maximum exposure ground-water concentrations and their corresponding intakes are shown for purposes of quantifying noncarcinogenic intakes in Table 3.4-2 and carcinogenic intakes in Table 3.4-3.

#### 3.4.3.4 Uncertainties Associated With the Exposure Assessment

The greatest uncertainty in the ground-water exposure assessment for the CFD is whether or not the water would ever be consumed. It is unlikely that wells will be developed on the site or in the area downgradient of the fill area, which is marshy and unsuitable for development. In addition, the fill area is located in a ground-water discharge area, which induces ground-water discharge to surface water, thus limiting the migration of contaminants in the ground-water flow system. No consideration was given to attenuation of concentration levels over time or distance from the site.

#### 3.4.4 Toxicity Assessment

The assessment of toxic and carcinogenic effects attributable to compounds found in ground water near the CFD site was conducted using the same procedures as those listed for the ASL in Section 2.5.4. This step in the risk assessment involved identifying relevant health risk values for the contaminants of concern. These health risk values are used with the estimated intake values calculated from the exposure assessment to calculate the risk due to exposure. To quantify noncarcinogenic risk, the chronic reference dose (RfD) in milligram of compound per kilogram of body weight per day (mg/kg·day) was used. The RfDs used in assessing toxic effects from compounds in ground water in the area of the CFD are included in Table 2.5-9. The risk value for carcinogens is the slope factor, which is measured in (mg/kg·day)<sup>-1</sup> and represents the upper 95th percentile confidence limit on the slope of the dose-response curve. Slope factors for carcinogenic compounds associated with the CFD ground water are included in Table 2.5-10.

The status of toxicity values for all compounds of concern was verified on IRIS (December 1992) and HEAST (Annual FY 1992). Several compounds are currently listed on IRIS or HEAST as being "under review" with respect to their noncarcinogenic toxicity values (RfDs), in which case a chemical-specific interpretation of the applicability of the use of quantitative toxicity values was made. A brief discussion of toxicity values which require qualifying statements with respect to their use in this risk assessment follows.

There is one compound, arsenic, which is currently under review on IRIS, which lists a HEAST sub-chronic toxicity value equal to the chronic IRIS value for arsenic. The arsenic chronic oral RfD is actually listed on IRIS, with the qualifying comment that there is still no clear consensus among the reviewers. In lieu of omitting arsenic from the risk assessment, this toxicity value was used. Inorganic mercury is currently under review on IRIS and HEAST, although a HEAST value is listed and was used in this assessment. There were no IRIS or HEAST data on cobalt, hence, risk could not be assessed. The toxicity value for trans-1,2-dichloroethene was used for total 1,2-dichloroethene; the cis isomer RfD is under review, and no RfD for total 1,2-dichloroethene exists.

The compounds trichloroethene and tetrachloroethene are both under review on IRIS and HEAST, with respect to their carcinogenic status and the assignment of an oral slope factor. Guidance from the USEPA Environmental Criteria and Assessment Office (Cincinnati, Ohio) on both compounds suggests that their weight-of-evidence classifications are on a C-B2 continuum, and states that the upper bound risk values/oral slope factors for trichloroethene ( $1.1\text{E-}02 \text{ (mg/kg/day)}^{-1}$ ) and tetrachloroethylene ( $5.2\text{E-}02 \text{ (mg/kg/day)}^{-1}$ ) have been reviewed by the IRIS-CRAVE workgroups but have not been verified on IRIS at this time. These values were used in this risk assessment.

#### 3.4.5 Risk Characterization

In this final step of the baseline risk assessment, the estimated daily intakes that were calculated in the exposure assessment were combined with the risk values identified in the toxicity assessment. In this way, any potential risk to human health due to ingestion of contaminants in the CFD site ground water was determined and quantified.

##### 3.4.5.1 Risk Characterization Methods for Noncarcinogens

The potential risk posed by the noncarcinogenic contaminants at the CFD site was estimated in the same manner as for the ASL site (Section 2.5.5.1). The ratio of the estimated daily intake to the oral RfD was determined as the



hazard quotient (HQ) for each compound. To determine total noncarcinogenic risk, the HQs for all the compounds were summed to determine the hazard index (HI). If the HI was less than one it was considered that there was little or no noncarcinogenic risk to the public for the sum of exposures to all compounds of potential concern. If the HI was greater than one, further evaluation of the types of critical effects associated with each compound was required.

#### 3.4.5.2 Risk Characterization Methods for Carcinogens

Carcinogenic risk from ingestion of ground water associated with the CFD site was determined in the same manner as for the ASL site (Section 2.5.5.2). The carcinogenic risk posed by each contaminant was determined by multiplying the estimated daily intake by the slope factor. This yielded the potential excess cancer risk associated with a lifetime of exposure to that compound at the exposure levels or intakes estimated in the exposure assessment. To determine the carcinogenic risk posed by total exposure to the ground water at the site, the risks of the individual contaminants were summed. Risks calculated in this way are potential risks and represent the excess cancer risks due to exposure from the CFD site.

#### 3.4.5.3 Risk Characterization for Ingestion of Ground Water Near the CFD

Ingestion of ground water from the vicinity of the CFD by hypothetical residents was evaluated as an exposure scenario under possible future use of the CFD site. The estimated daily intakes and risks associated with exposure to ground water from wells in the vicinity of the CFD are summarized for noncarcinogenic effects in Table 3.4-4 and for carcinogenic effects in Table 3.4-5.

For the average exposure scenario all individual HQs were less than 1.0, with the exception of arsenic. The sum of the individual HQs, the HI, was, therefore, also greater than one. This indicates that the risk of adverse noncarcinogenic effects is unacceptable for this pathway at an average level of exposure. In the RME scenario, the HQs for arsenic and zinc were both greater than one, making the overall HI greater than one. This indicates that, if this water were used as drinking water under the RME scenario, the risk of noncarcinogenic effects would exceed acceptable levels.

The noncarcinogenic effects of ingesting arsenic are hyperpigmentation (dark coloring of areas of skin) and keratosis (an overgrowth of horny tissue on areas of the skin). For the ingestion of zinc, the noncarcinogenic effects include anemia.

The assessment of carcinogenic risk for ground water near the CFD showed that the risk for the average exposure situation was  $2\text{E-}4$  (or 2 in 10,000), a level greater than the established potentially acceptable range of risk ( $10^{-6}$  through  $10^{-4}$ , or 1 in 1,000,000 through 1 in 10,000). The principal components of this risk level were beryllium and arsenic. For the RME exposure scenario the total risk was  $3\text{E-}3$  (or 3 in 1,000). This risk also resulted primarily from the ingestion of beryllium and arsenic.

The volatile organic compounds detected in CFD ground water [tetrachloroethene (PCE) and trichloroethene (TCE)] provided relatively small contributions to the overall carcinogenic excess cancer risk posed by the CFD. In the average exposure case, the individual risks from these compounds were less than  $1 \times 10^{-6}$  ( $1\text{E-}6$  or 1 in 1,000,000). This level has been referred to as a de minimis level of risk, which cannot be differentiated from background risk. In RME exposure, the risk for TCE is less than the de minimis risk, and the risk for PCE is  $2\text{E-}5$ , which is in the potentially acceptable range of risk. In both risk scenarios, risks posed by the two volatile organic compounds are several orders of magnitude less than the risk posed by either arsenic or beryllium.

Ingestion of beryllium has been characterized as being able to cause cancer, although this is primarily based on its potential to induce tumors following inhalation rather than ingestion. Limited and somewhat inconclusive experiments with animals given beryllium orally showed slight increases in lymphoma leukemias, although for most comparisons these were not statistically significant increases. Ingestion of arsenic has been shown to cause skin cancer. Because the carcinogenic effects of the two metals impact different organ systems, the carcinogenic effects of these two metals cannot be considered in an additive manner.

#### 3.4.5.4 Uncertainties in the Human Health Risk Assessment

There are uncertainties associated with the risk assessment process which can lead to either an underestimation or an overestimation of risk. In general, however, the risk assessment process is a conservative one. The risk assessment for the CFD presents two risk scenarios, as does the risk assessment for the ASL--one based on average exposure assumptions and one based on more conservative assumptions (reasonable maximum exposure)--to generate a range of potential risk for comparison. Each scenario has uncertainties associated with it which differ in magnitude but are similar in the nature of the uncertainties involved.

The data evaluation step has some uncertainty associated with it due to the selection of potential compounds of concern from the total list of compounds



detected. However, compounds of concern were selected based on specific criteria. The average concentration of a metal was first compared to the background concentration. If a metal was not detected in the background, it was automatically retained. If the metal was present at a level equal to or greater than 1.5 times the background, it was retained. Metals with concentrations less than or equal to 1.5 times their background were eliminated, unless they had highly toxic properties, in which case they were still retained. Metals that are known to be naturally occurring and that are characterized as essential human nutrients (calcium, iron, magnesium, potassium, and sodium) were eliminated based on these properties.

Compound concentration levels were next compared to any field or trip blank data and, if they were present at levels greater than five times the blank, they were retained. Chloroform was eliminated from this risk assessment based on its detection in the field blank. Based on this fairly conservative evaluation of the data, the overall additional risk that might be unaccounted for by the elimination of any detected compounds would not be appreciable.

The assessment of a single exposure pathway (the ingestion of ground water) and the elimination of surface water or sediment exposure pathways was justified based on the low potential for exposure via surface water or sediment. Since exposure by ingestion of water via the ground-water pathway does not occur at present and has a very low potential for occurring in the future, the inclusion of this pathway is a conservative measure. The exposure assumptions used in the average or the RME scenario lend their accompanying semi-conservatism and conservatism, respectively, to the analyses.

Toxicity values (i.e., RfDs and slope factors) have been established using conservative interpretations of the studies from which they derive, as well as being upper bound estimators for risk from individual compounds. The treatment of chromium as the trivalent form and lead as the inorganic form, and the use of the toxicity values specific for these forms, is warranted based on the absence of data to the contrary. In addition, there are certain compounds that were detected in ground water but which lack toxicity values, and hence do not factor into the quantitative risk assessment. Compounds lacking noncarcinogenic toxicity values (RfDs) included cobalt, lead, trichloroethene, alpha-BHC, beta-BHC, delta-BHC, and isodrin. The only compound that was lacking a carcinogenic toxicity value (the slope factor) was lead. The inability to include these compounds in the quantitation of risk for the CFD may introduce some amount of additional risk, but the relatively low levels at which these compounds are present do not lend themselves to substantial increases in risk.



#### 3.4.5.5 Risk Characterization Summary

It is highly unlikely that ground water from the vicinity of the CFD will ever be consumed. No individual wells are likely to be permitted on or near a former landfill site. Ingestion of ground water from the shallow, water-table aquifer without remediation is even less likely. However unlikely, risk from ground-water ingestion was quantified pending possible future land uses. The conclusion was that consumption of ground water from the vicinity of the CFD without remediation was unacceptable for both noncarcinogenic and carcinogenic effects under both the average and the reasonable maximum exposure scenarios.

#### 3.4.6 Comparison of Observed Ground Water Concentrations To Drinking Water Standards

After completion of the baseline risk assessment and before determination of remediation goals, RI/FS guidance dictates that applicable or relevant and appropriate requirements (ARARs) be identified. The following discussion compares concentrations found in ground water to drinking water regulations in the Safe Drinking Water Act (SDWA). This discussion compares observed maximum and average ground-water concentrations for individual compounds to their respective MCLs, MCLGs, and SMCLs. This same comparison for the ASL was included in Section 2.5.6. The drinking water standards for all CFD compounds of concern addressed in this risk assessment and their maximum and average ground-water concentrations are listed in Table 3.4-6.

A total of 14 compounds can be compared to at least one of the three established regulatory levels. Only the MCLs are enforceable standards. Those compounds which meet the MCL standards for both average and maximum concentrations include arsenic, chromium, mercury, 1,2-dichloroethene, heptachlor, and methoxychlor. The average concentration of trichloroethene was below the MCL; however, the maximum concentration slightly exceeded the MCL (MCL=0.005 mg/L, maximum=0.0054 mg/L).

Average and maximum observed ground-water concentrations for tetrachloroethene exceeded the established MCL for this compound, and average and maximum concentrations for beryllium and bis(2-ethylhexyl)phthalate exceeded their proposed MCLs. Average and maximum ground-water concentrations for lead were greater than the recently established action levels (ALs) for lead, which would trigger treatment actions in public water supply systems.

Manganese and zinc have no MCLs, but average and maximum observed concentrations exceeded their SMCLs. MCLGs are goals and are not enforceable but were exceeded for average and maximum observed concentrations for beryllium, tetrachloroethene, trichloroethene, and heptachlor, all of which



are considered to be carcinogenic and, therefore, have MCLGs of zero so that any detected value exceeds the MCLG.

Although arsenic was one of the major constituents of unacceptable risks from ingestion of ground water from the CFD area, the comparison of both the maximum and the average arsenic levels in ground water with the arsenic MCL indicates compliance with the drinking water standards. This seeming inconsistency stems from the modification of the arsenic MCL to be reflective of its potential as an essential human nutrient. This value was modified based on nutritional requirements published by the National Academy of Science (IRIS 1991). In other words, the MCL takes the nutritional requirement of arsenic into account while the toxicity values (RfD and slope factor) do not. The result is contradictory. The risk assessment using the toxicity values suggests that risk is unacceptable while even the maximum observed arsenic concentration is less than the MCL.

Given the conservative nature of the risk assessment, the low likelihood that water from the vicinity of the CFD will ever be used as a regular drinking water supply, and the fact that all observed arsenic concentrations are below the MCL, the reported arsenic levels cannot be considered high enough to necessitate ground-water remediation.

TABLE 3.4-1 CHEMICALS OF POTENTIAL CONCERN IN GROUND-WATER SAMPLES FROM THE VICINITY OF THE CFD<sup>(a)</sup>

Compound	Number Detected	CRL ( $\mu\text{g/L}$ )	Range of Detected Values		Background <sup>(a)</sup> ( $\mu\text{g/L}$ )	Mean ( $\mu\text{g/L}$ )	Standard Deviation ( $\mu\text{g/L}$ )	95% UCL ( $\mu\text{g/L}$ )
			Minimum ( $\mu\text{g/L}$ )	Maximum ( $\mu\text{g/L}$ )				
METALS								
Aluminum	4	<112	614	14,800	15,100	4,810	6,250	12,600
Arsenic	3 <sup>(a)</sup>	<2.35	6.76	29.5	62.8	21.0	12.4	51.9
Barium	5	<2.82	13.7	94.4	214	44.3	32.8	85.0
Beryllium	2	<1.12	3.25	48.5	4.38	10.7	21.2	37.0
Calcium	5	<105	1,750	74,300	11,900	17,300	31,900	56,900
Chromium	2	<16.8	24.0	48.6	129	19.6	17.6	41.4
Cobalt	1	<25.0	46.3	46.3	<25.0	19.3	15.1	38.0
Copper	3	<18.8	29.7	79.5	143	32.7	28.7	68.3
Iron	5	<77.5	150	97,600	66,400	23,000	41,900	75,000
Lead	3	<4.47	71.1	168	103	79.1	79.2	177
Magnesium	5	<135	576	9,310	1,560	3,560	3,510	7,920
Manganese	5	<9.67	23.7	211	74.4	101	72.2	191
Mercury	1	<0.10	0.160	0.160	0.160	0.072	0.049	0.133
Nickel	2	<32.1	39.9	86.0	48.9	34.8	30.4	72.6
Potassium	3	<1,240	2,300	5,500	5,580	2,520	2,080	5,100
Silver	2	<0.33	0.420	1.44	1.01	0.471	0.553	1.16
Sodium	5	<279	1,840	14,300	3,910	6,590	5,140	13,000
Vanadium	2	<27.6	72.8	107	204	44.2	43.4	98.1
Zinc	5	<18.0	98.2	12,000	183	7,180	5,360	13,800
VOLATILE ORGANIC COMPOUNDS								
Chloroform	1	<1.0	4.10	4.10	<1.0	1.22	1.61	3.22
1,2-Dichloroethene (total)	1	<5.0	5.91	5.91	<5.0	3.18	1.53	5.08
Tetrachloroethene	1	<1.0	37.0	37.0	<1.0	7.80	16.3	28.1
Trichloroethene	1	<1.0	5.40	5.40	<1.0	1.48	2.19	4.20
SEMIVOLATILE ORGANIC COMPOUNDS								
Bis(2-ethylhexyl)phthalate	1	<7.70	29.3	29.3	<7.70	8.94	11.4	23.1

(a) A total of 5 samples are summarized in this table.  
 (b) Background concentrations are from CFD-1.  
 (c) For arsenic, there are a total of only 3 samples.



TABLE 3.4-1 (Cont.)

Compound	Number Detected	CRL ( $\mu\text{g/L}$ )	Range of Detected Values		Background <sup>(b)</sup> ( $\mu\text{g/L}$ )	Mean ( $\mu\text{g/L}$ )	Standard Deviation ( $\mu\text{g/L}$ )	95% UCL ( $\mu\text{g/L}$ )
			Minimum ( $\mu\text{g/L}$ )	Maximum ( $\mu\text{g/L}$ )				
PESTICIDES								
Aldrin	1	<0.0074	0.010	0.010	0.011	0.0050	0.0028	0.0085
Alpha-BHC	1	<0.0025	0.0040	0.0040	<0.0025	0.0018	0.0012	0.0033
Delta-BHC	3	<0.0034	0.0060	0.011	<0.0034	0.0055	0.0039	0.010
Dieldrin	1	<0.0074	0.064	0.064	<0.0074	0.016	0.027	0.049
Heptachlor	1	<0.0025	0.052	0.052	<0.0025	0.011	0.023	0.040
Isodrin	1	<0.0025	0.0060	0.0060	0.0030	0.0022	0.0021	0.0048
Methoxychlor	1	<0.0750	0.230	0.230	<0.0750	0.076	0.086	0.183

TABLE 3.4-2 CHRONIC INGESTION (ORAL) EXPOSURE ESTIMATES FOR NONCARCINOGENS IN CFD GROUND WATER

Parameter	Average Ground-Water Concentration ( $\mu\text{g/L}$ )	Reasonable Maximum Exposure Ground-Water Concentration ( $\mu\text{g/L}$ )	Average Oral Intake ( $\text{mg/kg}\cdot\text{day}$ )	Reasonable Maximum Exposure Oral Intake ( $\text{mg/kg}\cdot\text{day}$ )
<b>METALS</b>				
Arsenic	2.1E+1	5.2E+1	4.0E-4	1.4E-3
Beryllium	1.1E+1	3.7E+1	2.0E-4	1.0E-3
Chromium	2.0E+1	4.1E+1	3.7E-4	1.1E-3
Cobalt	1.9E+1	3.8E+1	3.6E-4	1.0E-3
Lead	7.9E+1	1.8E+2	1.5E-3	4.8E-3
Manganese	1.0E+2	1.9E+2	1.9E-3	5.2E-3
Mercury	7.2E-2	1.3E-1	1.4E-6	3.6E-6
Zinc	7.2E+3	1.4E+4	1.4E-1	3.8E-1
<b>VOLATILE ORGANIC COMPOUNDS</b>				
1,2-Dichloroethene (total)	3.2E+0	5.1E+0	6.0E-5	1.4E-4
Tetrachloroethene	7.8E+0	2.8E+1	1.5E-4	7.7E-4
Trichloroethene	1.5E+0	4.2E+0	2.8E-5	1.2E-4
<b>SEMIVOLATILE ORGANIC COMPOUNDS</b>				
Bis(2-ethylhexyl)phthalate	8.9E+0	2.3E+1	1.7E-4	6.3E-4
<b>PESTICIDES</b>				
Aldrin	5.0E-3	8.5E-3	9.5E-8	2.3E-7
Alpha-BHC	1.8E-3	3.3E-3	3.4E-8	9.0E-8
Delta-BHC	5.5E-3	1.0E-2	1.0E-7	2.7E-7
Dieldrin	1.6E-2	4.9E-2	3.0E-7	1.3E-6
Heptachlor	1.1E-2	4.0E-2	2.1E-7	1.1E-6
Isodrin	2.2E-3	4.8E-3	4.2E-8	1.3E-7
Methoxychlor	7.6E-2	1.8E-1	1.4E-6	5.0E-6



TABLE 3.4-3 CHRONIC INGESTION (ORAL) EXPOSURE ESTIMATES FOR CARCINOGENS IN CFD GROUND WATER

<u>Parameter</u>	<u>Average Ground-Water Concentration (<math>\mu\text{g/L}</math>)</u>	<u>Reasonable Maximum Exposure Ground-Water Concentration (<math>\mu\text{g/L}</math>)</u>	<u>Average Oral Intake (<math>\text{mg/kg}\cdot\text{day}</math>)</u>	<u>Reasonable Maximum Exposure Oral Intake (<math>\text{mg/kg}\cdot\text{day}</math>)</u>
<b>METALS</b>				
Arsenic	2.1E+1	5.2E+1	5.1E-5	6.1E-4
Beryllium	1.1E+1	3.7E+1	2.6E-5	4.3E-4
Lead	7.9E+1	1.8E+2	1.9E-4	2.1E-3
<b>VOLATILE ORGANIC COMPOUNDS</b>				
Tetrachloroethene	7.8E+0	2.8E+1	1.9E-5	3.3E-4
Trichloroethene	1.5E+0	4.2E+0	3.6E-6	4.9E-5
<b>SEMI-VOLATILE ORGANIC COMPOUNDS</b>				
Bis(2-ethylhexyl)phthalate	8.9E+0	2.3E+1	2.2E-5	2.7E-4
<b>PESTICIDES</b>				
Aldrin	5.0E-3	8.5E-3	1.2E-8	1.0E-7
Alpha-BHC	1.8E-3	3.3E-3	4.4E-9	3.9E-8
Dieldrin	1.6E-2	4.9E-2	3.9E-8	5.8E-7
Heptachlor	1.1E-2	4.0E-2	2.7E-8	4.7E-7

TABLE 3.4-4 CHRONIC INGESTION (ORAL) RISK ESTIMATES FOR NONCARCINOGENS IN CFD GROUND WATER

<u>Parameter</u>	<u>Average Oral Intake (mg/kg-day)</u>	<u>Reasonable Maximum Exposure Oral Intake (mg/kg-day)</u>	<u>Oral RfD (mg/kg-day)</u>	<u>Average Hazard Quotient</u>	<u>Reasonable Maximum Exposure Hazard Quotient</u>
<b>METALS</b>					
Arsenic	4.0E-4	1.4E-3	3E-4	1.3E+0	4.7E+0
Beryllium	2.0E-4	1.0E-3	5E-3	4.0E-2	2.0E-1
Chromium	3.7E-4	1.1E-3	1E+0	3.7E-4	1.1E-3
Cobalt	3.6E-4	1.0E-3	ND	---	---
Lead	1.5E-3	4.8E-3	Pending	---	---
Manganese	1.9E-3	5.2E-3	Withdrawn	---	---
Mercury	1.4E-6	3.6E-6	3E-4	4.5E-3	1.2E-2
Zinc	1.4E-1	3.8E-1	3E-1	4.5E-1	1.3E+0
<b>VOLATILE ORGANIC COMPOUNDS</b>					
1,2-Dichloroethene (total)	6.0E-5	1.4E-4	2E-2	3.0E-3	7.5E-3
Tetrachloroethene	1.5E-4	7.7E-4	1E-2	1.5E-2	7.7E-2
Trichloroethene	2.8E-5	1.2E-4	Pending	---	---
<b>SEMIVOLATILE ORGANIC COMPOUNDS</b>					
Bis(2-ethylhexyl)phthalate	1.7E-4	6.3E-4	2E-2	8.5E-3	3.2E-2
<b>PESTICIDES</b>					
Aldrin	9.5E-8	2.3E-7	3E-5	3.2E-3	7.8E-3
Alpha-BHC	3.4E-8	9.0E-8	NA	---	---
Delta-BHC	1.0E-7	2.7E-7	NA	---	---
Dieldrin	3.0E-7	1.3E-6	5E-5	6.0E-3	2.7E-2
Heptachlor	2.1E-7	1.1E-6	5E-4	4.2E-4	2.2E-3
Isodrin	4.2E-8	1.3E-7	---	---	---
Methoxychlor	1.4E-6	5.0E-6	5E-3	2.9E-4	1.0E-3
Average Hazard Index = 2E+0					
Reasonable Maximum Exposure (RME) Hazard Index = 6E+0					

NA Not Available  
ND Not Determined



TABLE 3.4-5 CHRONIC INGESTION (ORAL) RISK ESTIMATES FOR CARCINOGENS IN CFD GROUND WATER

<u>Parameter</u>	<u>Average Oral Intake (mg/kg·day)</u>	<u>Reasonable Maximum Exposure Oral Intake (mg/kg·day)</u>	<u>Oral Slope Factor (mg/kg·day)</u>	<u>Average Risk</u>	<u>Reasonable Maximum Exposure Risk</u>
<b>METALS</b>					
Arsenic	5.1E-5	6.1E-4	1.8E+0	9.2E-5	1.1E-3
Beryllium	2.6E-5	4.3E-4	4.3E+0	1.1E-4	1.9E-3
Lead	1.9E-4	2.1E-3	NA	---	---
<b>VOLATILE ORGANIC COMPOUNDS</b>					
Tetrachloroethene	1.9E-5	3.3E-4	5.1E-2	9.7E-7	1.7E-5
Trichloroethene	3.6E-6	4.9E-5	1.1E-2	4.0E-8	5.4E-7
<b>SEMIVOLATILE ORGANIC COMPOUNDS</b>					
Bis(2-ethylhexyl)phthalate	2.2E-5	2.7E-4	1.4E-2	3.0E-7	3.8E-6
<b>PESTICIDES</b>					
Aldrin	1.2E-8	1.0E-7	1.7E+1	2.1E-7	1.7E-6
Alpha-BHC	4.4E-9	3.9E-8	6.3E+0	2.8E-8	2.4E-7
Dieldrin	3.9E-8	5.8E-7	1.6E+1	6.2E-7	9.2E-6
Heptachlor	2.7E-8	4.7E-7	4.5E+0	1.2E-7	2.1E-6
<div> <div>Total Excess Lifetime Cancer Risk, Average Case = 2E-4</div> <div>Total Excess Lifetime Cancer Risk, Reasonable Maximum Exposure (RME) = 3E-3</div> </div>					

NA Not Available

TABLE 3.4-6 DRINKING WATER STANDARDS AND OBSERVED GROUND WATER CONCENTRATIONS FOR CHEMICALS OF CONCERN FOUND AT CFD

Clean Fill Dump (CFD)						
Compound	Site/Media	NPDWR/MCL (mg/L)	SMCL (mg/L)	MCLG (mg/L)	Observed Ground-Water Concentration	
					Maximum (mg/L)	Average (mg/L)
METALS						
Arsenic	CFD, sed	0.05			0.029	0.021
Beryllium	CFD, sed	0.001 <sup>(a)</sup>		0.0 <sup>(a)</sup>	0.0485	0.0107
Chromium (Total)	CFD, sed	0.1		0.1	0.0486	0.0196
Cobalt	CFD, sed				0.0463	0.0193
Lead	CFD, sed	0.015/TT <sup>(a)</sup>			0.168	0.0792
Manganese	CFD, sed, sw		0.05		0.211	0.101
Mercury	CFD	0.002		0.002	0.00016	0.000072
Zinc	CFD, sed		5.0		12.0	7.18
VOLATILE ORGANIC COMPOUNDS						
cis-1,2-Dichloroethene <sup>(a)</sup>	CFD	0.07		0.07	0.0059 <sup>(a)</sup>	0.00318 <sup>(a)</sup>
trans-1,2-Dichloroethene <sup>(a)</sup>	CFD	0.1		0.1	0.0059 <sup>(a)</sup>	0.00318 <sup>(a)</sup>
Tetrachloroethene	CFD	0.005		0.0	0.037	0.0078
Trichloroethene	CFD	0.005		0.0	0.0054	0.00148
SEMI-VOLATILE ORGANIC COMPOUNDS						
Bis(2-Ethylhexyl)Phthalate	CFD	0.004 <sup>(a)</sup>			0.029	0.00894
PESTICIDES						
Aldrin	CFD				0.00001	0.0000050
Alpha-BHC	CFD				0.000004	0.0000018
Delta-BHC	CFD, sw				0.000011	0.0000055
Dieldrin	CFD, sed				0.000064	0.000016
Heptachlor	CFD, sed	0.0004		0.0	0.000052	0.000011
Isodrin	CFD, sw				0.000006	0.0000022
Methoxychlor	CFD	0.04		0.04	0.00023	0.000076

(a) Proposed value.

(b) The NPDWR requires a treatment actions if &gt; 10 percent of targeted tap samples exceed the action limit (AL) of 15 mg/L for lead.

(c) The compound analyzed for in this RI was the combination of cis- and trans-1,2-dichloroethene

se, sed: The compound was also found in other media including surface water (sw) or sediment (sed).



#### 4. SUMMARY AND CONCLUSIONS

##### 4.1 ACTIVE SANITARY LANDFILL

###### Project Background

EA conducted a two-phase Remedial Investigation project at the ASL that included collection of surface water, stream sediment, leachate, soil gas, and ground-water samples for analysis. These samples, except for the soil gas, were analyzed for the TCL and TAL parameters. The first phase included installation of 12 shallow monitoring wells and four deep monitoring wells. The second phase included the installation of five shallow monitoring wells and one deep well. The objective of the second well installation phase was to further define the extent of contamination along the southeastern ASL boundary. The analytical data presented in this report were obtained from the analysis of samples collected in March-April 1991.

###### Site Description

The ASL encompasses approximately 130 acres of land and is situated along the FGGM eastern boundary. The ASL was constructed as an unlined facility and is divided into three operational cells (Cells 1, 2, and 3). The ASL accepts sanitary waste generated by the installation. It has been reported that this facility has accepted petroleum waste, contaminated soil excavated from UST sites, and pesticides.

The surrounding private land use consists of an Amtrak facility to the southeast, and two trailer parks and an electrical contractor facility to the east. A utility power line and a small wooded area border the site to the north. An area of wet woods is located within the permitted area adjacent to the fill areas to the west. An inactive ammunition supply point and wooded areas are located to the west and south. The ASL and adjacent property to the north, west, and south of the site is to be retained by FGGM and is not included in the 7,600-acre transfer to the Patuxent Wildlife Research Center.

###### Physical Characterization

###### Hydrology

Two small surface streams flow from east to west across the central region of the site between Cells 1 and 2.

## Site Geology and Hydrogeology

Field investigations confirmed that the ASL is located in the outcrop area of the Potomac Group. The Potomac Group is approximately 600+ ft thick in the study area and has been subdivided into the Patapsco, Arundel, and Patuxent formations. These formations dip to the southeast and are made up of sand, silt, clay and gravel layers that are commonly intermixed and limited in lateral extent. In this area the Patapsco Formation can be divided into the upper and lower Patapsco aquifers, and a middle confining layer. The upper Patapsco Formation (exposed at the site) ranges in thickness from 5 to 10 ft west of the ASL and from 30 to 40 ft east of the ASL. The middle confining layer crops out to the west of the site and averages 50 ft thick across the site. Field drilling revealed that this confining layer is continuous across the site and the upper surface slopes to the southeast.

Ground water exists under both unconfined and confined conditions beneath the site. The upper Patapsco Formation acts as the water-table aquifer. This unit is hydraulically separate from the lower Patapsco Formation, which is the uppermost confined aquifer at the site. There is a downward vertical gradient between the shallow and deep wells, which is evidenced by a 40 to 60 ft difference in water levels.

The direction of ground-water flow in the water-table aquifer is controlled by the natural topography and the buildup of waste in Cells 1 and 2 onsite and by the elevated rail lines that are located immediately east of the ASL and FGGM boundary. The direction of ground-water flow in the central and northern regions of the site is to the west. The ground-water flow direction along the southern and eastern landfill boundaries is to the south and southeast, respectively. The southerly flow direction off the southern and eastern ASL boundaries is consistent with the regional flow patterns.

A partial record of water supply wells was compiled during this study. This well survey does not identify any domestic use of the water-table aquifer southeast of the ASL. It is possible, however, that there are pre-1969 wells in use to the southeast of the ASL along Patuxent Road.

The water-level elevations obtained during this study from the wells completed in the lower Patapsco aquifer revealed a southeast slope to the potentiometric surface for this aquifer. This slope is consistent with the southeastward dip of this formation.



### Terrestrial Resources

The ASL and environs was characterized as open field/vegetated landfill, wetwoods, and upland woods. A bifurcated stream drains the landfill.

### Aquatic Resources

The ASL operations have affected surface waters of the site by modification of the topography and consequential alteration of the drainage pattern of the site. The surface waters within the ASL site are of poor quality for utilization by wildlife and aquatic organisms.

The results of EA's benthic invertebrate and fishery survey indicate that the sampling station below the ASL has a stressed benthic and fish community when compared to an upstream station. The station downstream of the ASL has better habitat quality. The results indicate that although the water quality near the ASL may be sufficiently degraded to cause stress and health effects to fish, it does not appear sufficiently degraded to affect the types of fishes occurring downstream.

Wetlands areas have developed in depressions on the fill cell's surface and along the fill cell bases, and at seeps around the fill perimeter. Wetland areas, including wet woods, were modified or filled for establishment of the landfill facility.

### Nature and Extent of Contamination

#### Surficial Soil

Analysis of three surficial soil samples revealed one volatile organic compound (2-butanone at 8.16  $\mu\text{g/g}$ ) in one of the samples. No semivolatile organic compounds were detected and no elevated metals values were noted.

Low levels of six pesticides were detected in one sample, and two pesticides were detected in another sample. The low levels detected are not thought to be a cause for concern.

Six surface water and stream sediment samples (Section 2.3.4) were collected for analysis from around the ASL. No volatile organic compounds were detected in any of the samples. Low levels of five semivolatile organic compounds were detected in one sample, which was collected from a stagnant waterbody along the eastern ASL boundary.

There were no cases where the measured concentrations exceeded the acute criterion.

#### Ground Water

Data from previous studies indicated that the landfill was contributing to low level volatile organic contamination of the water-table (upper Patapsco) aquifer. The monitoring well network was designed to monitor water quality in the water-table aquifer and the uppermost confined (lower Patapsco) aquifer.

#### Upper Patapsco

A review of these data (Section 2.3.5) confirmed that the landfill is a source of low-level volatile organic contamination in the water-table aquifer. Volatile organic compounds were detected in 17 of the 20 samples collected from the wells completed in the water-table aquifer. The compounds detected included benzene, toluene, ethylbenzene, total xylenes, chlorobenzene, chloroform, 1,1-dichloroethane, 1,2-dichloroethene, 1,2-dichloropropane, tetrachloroethene, trichloroethene, 1,3-dimethylbenzene, dichlorobenzene, methylisobutyl ketone, and trichlorofluoromethane.

The total volatile organic compounds for each well and leachate sample were plotted in Figure 2.3-1 to show the spatial distribution of this contamination. This figure shows that the samples (MW-9 and MW-15) with the highest volatile organic levels were located immediately downgradient of the ASL on the western boundary and that the total values decrease to the west of these wells. This figure also shows that the extent of contamination to the west, south, and southeast of the ASL has not been fully defined.

In comparing the data to the regulatory criteria (MCL or MCLG), benzene was the only volatile organic compound that exceeded these criteria. The MCL for benzene is 5  $\mu\text{g/L}$  and the MCLG is 0  $\mu\text{g/L}$ . These values were exceeded in four wells: MW-9 (6.59  $\mu\text{g/L}$ ), MW-12S (6.43  $\mu\text{g/L}$ ), MW-16 (5.43  $\mu\text{g/L}$ ), and MW-19 (12.4  $\mu\text{g/L}$ ) and are shown in Figure 2.3-1. Slightly lower benzene values compared to the MCL were reported for samples collected from MW-13 (3.64  $\mu\text{g/L}$ ), MW-14 (4.96  $\mu\text{g/L}$ ), and MW-15 (4.57  $\mu\text{g/L}$ ). MW-12S, MW-14, and MW-19 are all located adjacent to the southeastern ASL boundary. This proximity to the ASL boundary coupled with the lack of any monitoring wells located further southeast of this area outside of the FGGM property prohibits definition of the extent of contamination in this direction.

Low levels of pesticides were detected in 16 of the 20 samples completed in the water-table aquifer. None of the pesticide values exceeded the respective



MCLs; however, the lindane value detected in the MW-17 sample equaled its MCL (0.20  $\mu\text{g/L}$ ). Further monitoring is warranted based on these data.

The total and dissolved metals data were compared to the MCL, SMCL, or AL criteria. There are no total or dissolved metals above the MCLs or ALs except for the one total lead value (MW-15 at 18.3  $\mu\text{g/L}$ ), which is slightly higher than the AL for lead (15  $\mu\text{g/L}$ ). The data from this round of samples do not indicate that the ASL is negatively impacting the water quality in the water-table aquifer in regards to metals.

Note: Risks (noncarcinogenic HI and cancer risks) are calculated using toxicity values, not MCLs. Sometimes, as in the case of arsenic, the risk assessment is not consistent with MCL levels.

#### Lower Patapsco

There were no volatile organic compounds detected in the six lower Patapsco wells.

A number of pesticides were detected in all of the samples collected from the deep wells, including the upgradient well. None of these values exceed any of the regulatory criteria. Given the hydrogeologic conditions at the site and the lack of any volatile organic compounds in this deep aquifer, a level of uncertainty exists whether the pesticide data are attributable to the ASL.

Metals concentrations found in the samples from the lower Patapsco wells are not a concern and are associated with the natural water quality.

#### Leachate

Analytical results obtained from the analysis of leachate sample L-1 showed elevated levels of six volatile organic compounds. The analytical results indicate similar results in the vicinity of the ASL.

#### Soil Gas

The soil gas samples were analyzed for methane, aromatic hydrocarbons, and chlorinated hydrocarbons. Elevated methane concentrations were located along the southern and northern boundaries. Highest levels of hydrocarbon contamination were located in the northern area of Cell 1. Methane levels will require survey during landfill closure as a pre-design determination of the need for a gas venting system.

### Contaminant Fate and Transport

The contaminant migration route of concern is the ground-water flow regime in the water-table aquifer. The primary environmental concern is the volatile organic contamination. This route of migration was evaluated through the use of two ground-water models (Section 2.4.4). MODFLOW was utilized to calibrate the flow field in the water-table aquifer, and the resultant boundary conditions were used to execute MOC, a two-dimensional solute transport model.

The model results show that the contaminant movement occurs in a westerly direction consistent with the surface stream flow direction along the western boundary. The model results also show that the contaminants are projected to migrate in a southeast direction across the FGGM boundary with the plume extending as far east as Patuxent Road.

### Human Health Risk Assessment

Risk assessment is generally a conservative process with a measure of uncertainty innate to the process.

The primary pathway for exposure in the vicinity of the ASL is from the ingestion of ground water from both the water-table and confined aquifers potentially affected by the ASL. A quantitative risk assessment (Section 2.5) was completed under current land use conditions involving the potential consumption of the ground water. This process involved evaluating the risk potential relative to average and reasonable maximum exposure (RME) exposures for both carcinogenic and noncarcinogenic effects. Although there is no onsite use of this aquifer, there are six residents located southeast of the ASL along Galloway Road that may draw potable water from this aquifer.

While the consumption of ground-water from the upper Patapsco aquifer under average exposure conditions is negligible, the RME scenario resulted in noncarcinogenic risks greater than the acceptable level. Carcinogenic risk for this aquifer was marginally acceptable for the average exposure but unacceptable for the RME. The major component of both risk potentials is arsenic. Note that there are no arsenic values over the MCL (50  $\mu\text{g/L}$ ). In fact, the maximum arsenic observation of 38  $\mu\text{g/L}$  is well below the MCL.

Noncarcinogenic risk from consuming water from the lower Patapsco aquifer was acceptable under the average or RME exposure.



Carcinogenic effects of consuming water from the confined aquifer were acceptable under the average exposure scenario. However, the RME risk was not acceptable. The majority of the risk under RME exposure assumptions was attributed to beryllium.

#### Preliminary Qualitative Ecological Impact Assessment

Based on a review of the existing data, the ASL may present an ecological risk due to the exposure of organisms to released contaminants. Contaminant effects, while potentially present, would be localized in the vicinity of the ASL, and likely do not pose a substantial threat to natural resources site-wide. However, the intensity and extent of risks cannot be fully quantified with present data.

## 4.2 CLEAN FILL DUMP

A two-phase study was conducted at this site concurrently with the ASL study. The first phase included the installation of five monitoring wells. The results of this phase included the detection of two volatile organic compounds in one of the ground-water samples collected from these initial wells. The levels of one of these compounds exceeded the MCL. The second phase of this study included the installation of one monitoring well. Results of this phase indicated that the CFD was impacting the water quality in the water-table aquifer.

### Site Background

The CFD is an inactive, unlined facility that was designed to accept inert material from the installation. It is located along the eastern boundary of FGGM in a lowland area. The CFD is included in the 7,600 acres that was transferred to the Patuxent Wildlife Research Center on 16 October 1991. This fill area consists of approximately 15 acres and was in operation using the area-fill method from 1972 to 1985. Although this area was designed to accept inert materials, other waste may have been disposed since the landfill was not secured. Waste material was also placed in an area of uncontrolled surface dumping located adjacent to the CFD along Boundary Road.

### Site Characterization

The site is surrounded by wooded areas on the north, west, and east and by a low-lying marshy area adjacent to the southern boundary. The closest surface stream is a small unnamed stream located approximately 1,000 ft south of the site. The Little Patuxent River lies approximately 1,200 ft south of the site.

### Site Geology

The field investigation conducted at the CFD and the review of available literature indicated that the subsurface materials consisted of Patuxent River terrace deposits and alluvium overlying the Potomac Group sedimentary deposits. These deposits consisted primarily of clayey sand and silt with interbedded layers of sand and gravel.

Ground water exists under unconfined and confined conditions at this site which are similar to the ground-water conditions that have been described for the ASL. The field investigation conducted at the CFD was designed to evaluate the ground-water quality and movement in the water-table aquifer.



The direction of ground-water flow at this site is to the south toward the marshy area. The site is located in a ground-water discharge area.

Impacts to natural resources at the northern fill area of the CFD are associated with the dumping and burial of materials at this location. The primary physical changes that occurred as a result of the operation of the CFD are change in vegetative cover and the filling of nontidal wetland area.

The wildlife habitat does not appear to have been adversely affected due to the operation of the CFD, with the possible exception of surface water quality.

The benthic invertebrate community composition near the CFD indicates that the community at this sampling station is depressed; however, this station is not an outlier when compared to the other stations sampled within Fort Meade. The fish community composition does not suggest any impairment due to the proximity of the CFD.

#### Contamination Assessment

One ground-water sample exhibited elevated levels of trichloroethene (TCE) (7.25  $\mu\text{g/L}$ ) and tetrachloroethene (PCE) (56.0  $\mu\text{g/L}$ ). The TCE level exceeds the final MCL (5  $\mu\text{g/L}$ ) and the PCE level exceeds the proposed MCL (5  $\mu\text{g/L}$ ). These compounds were not detected in the ground-water sample collected from CFD-3D, the deep well located next to CFD-3S.

Low levels of pesticides were detected in four of the six samples. None of these levels exceeded regulatory criteria. The presence of these low levels of pesticides is a minor concern.

The total arsenic, lead, and chromium values from the upgradient well exceeded the regulatory criteria. The total lead values exceeded regulatory criteria in three downgradient well samples. No dissolved metals values for any of the ground-water samples exceeded regulatory criteria.

There were no volatile or semivolatile organic compounds detected in the surface water or stream sediment sample. Low levels of pesticides were detected in the surface water and sediment sample.

The copper level in the stream sediment sample exceeded the acute ambient surface water quality criteria.

### Risk Assessment

Volatile organic compounds and metals values reported in the ground water are the compounds of concern at this site. Ingestion of ground water was evaluated as a potential exposure scenario.

The risk assessment concluded that consumption of ground water was unacceptable for both noncarcinogenic and carcinogenic effects under the average and the reasonable maximum exposure scenarios. Noncarcinogenic risk can be attributed to arsenic in the average exposure case and to arsenic and zinc in the RME. Cancer risk can be attributed to beryllium in the average exposure case and to beryllium and arsenic in the RME.

The ground-water exposure pathway is limited by the vertical upward ground-water gradient at the site which induces discharge of ground water to surface water. This provides no transport mechanism for contaminants to migrate within the ground water.



## 5. RECOMMENDATIONS

### 5.1 ACTIVE SANITARY LANDFILL

Based on the conclusions presented in Section 4, the following recommendations were developed.

1. Conduct a water supply well survey along Patuxent Road/Galloway Road to collect information on ground-water use and identify potential receptors of concern.
2. Install four shallow monitoring wells and two monitoring well clusters outside the existing well network to more fully define the extent of contamination. Two of the shallow wells should be placed to the west of the confluence of the surface streams in the ammunition supply point area. The other two shallow wells should be located southwest and south of the ASL. The well clusters should be installed southeast of the ASL beyond the reservation boundary to the east of the Amtrak rail lines. The proposed construction and location of these well clusters should be modified by the information obtained from the well survey.
3. Following installation of these additional wells, conduct a complete sampling event that includes surface water, leachate, and ground water. Samples should be analyzed for TCL/TAL parameters and indicator parameters such as chloride, nitrate, total dissolved solids, sulfate, and turbidity.
4. Perform surficial soil sampling to create an expanded database. A total of 20 additional samples should be collected and analyzed for TCL/TAL parameters plus cyanide. Three samples should be taken to provide information for site-specific background. The 17 onsite samples should be taken from a spatial grid developed for the ASL.

## 5.2 CLEAN FILL DUMP

The following recommendation was developed based on the conclusions presented in Section 4 of this report.

1. Annual ground-water and surface water sampling for a period of 5 years is recommended to expand the database and monitor water quality over time. There is no need for additional wells at this site. However, two additional surface water sampling stations should be located closer to the site and included in the monitoring program. One of these stations should be located in proximity to the CFD-3 well cluster.



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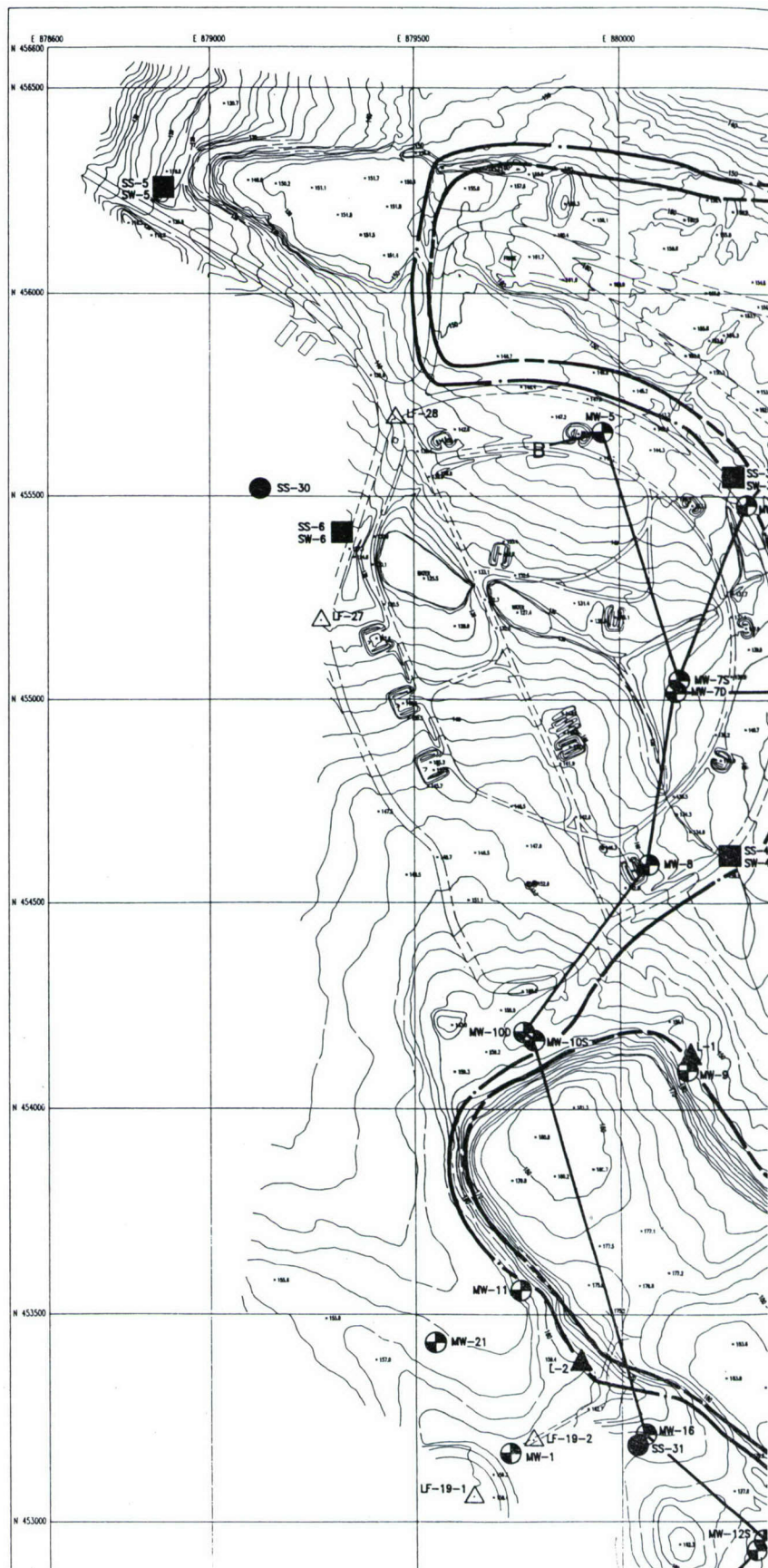
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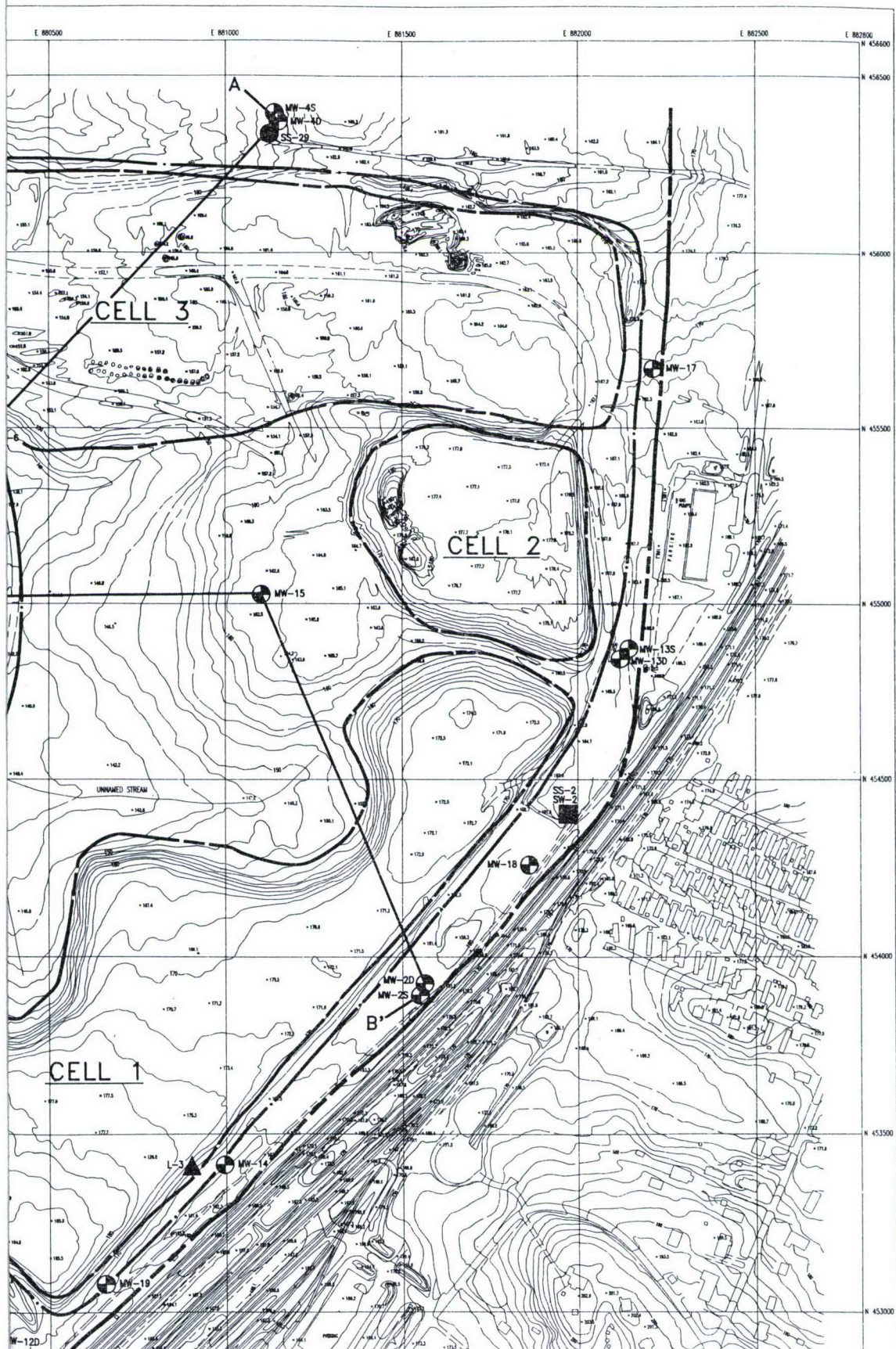
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### MONITORING WELL LOCATION DATA

WELL DESIGNATION	NORTHING	EASTING	TOP OF PVC ELEVATION (FT)
MW-1	453,166	879,727	163.18
MW-2S	453,893	881,549	163.93
MW-2D	453,926	881,562	162.67
MW-4S	456,397	881,140	161.88
MW-4D	456,372	881,151	161.71
MW-5	455,659	879,959	148.50
MW-6	455,479	880,312	143.77
MW-7S	455,048	880,147	137.99
MW-7D	455,020	880,139	137.37
MW-8	454,595	880,071	141.76
MW-9	454,110	880,168	157.78
MW-10S	454,171	879,783	159.39
MW-10D	454,181	879,764	159.62
MW-11	453,559	879,754	159.94
MW-12S	452,949	880,345	174.44
MW-12D	452,934	880,333	174.52
MW-13S	454,873	882,143	169.16
MW-13D	454,843	882,118	168.05
MW-14	453,414	880,995	165.68
MW-15	455,027	881,103	165.47
MW-16	453,203	880,056	174.96
MW-17	455,671	882,216	171.81
MW-18	454,260	881,861	167.84
MW-19	453,079	880,656	170.01
MW-20	452,677	880,280	171.70
MW-21	453,432	879,547	156.89






### SAMPLING LOCATION DATA

SAMPLING DESIGNATION	NORTHING	EASTING	SURFACE ELEVATION (FT)
L-1	454,115	880,170	155.0
L-2	453,380	879,900	158.0
L-3	453,400	880,900	168.0
SW-2	454,400	882,000	161.0
SS-2	454,400	882,000	161.0
SW-3	455,550	880,280	141.0
SS-3	455,550	880,280	140.0
SW-4	454,500	880,100	137.0
SS-4	454,500	880,100	136.0
SW-5	456,000	879,000	116.0
SS-5	456,000	879,000	116.0
SW-6	455,150	879,150	120.0
SS-6	455,150	879,150	120.0
SW-7	455,000	878,000	113.0
SS-7	455,000	878,000	112.0
SS-29	456,342	881,130	159.0
SS-30	455,520	879,125	130.0
SS-31	453,200	880,050	172.0
USGS-CC40	451,400	879,300	140.0

### SURVEY CONTROL POINT LOCATION DATA

POINT NUMBER	NORTHING	EASTING	ELEVATION (FT)
LF-14	452,801	880,437	168.26
LF-15	452,600	880,199	164.02
LF-27	455,195	879,270	128.80
LF-28	455,695	879,454	139.98
LF-19-1	453,061	879,637	157.83
LF-19-2	453,198	879,783	160.64

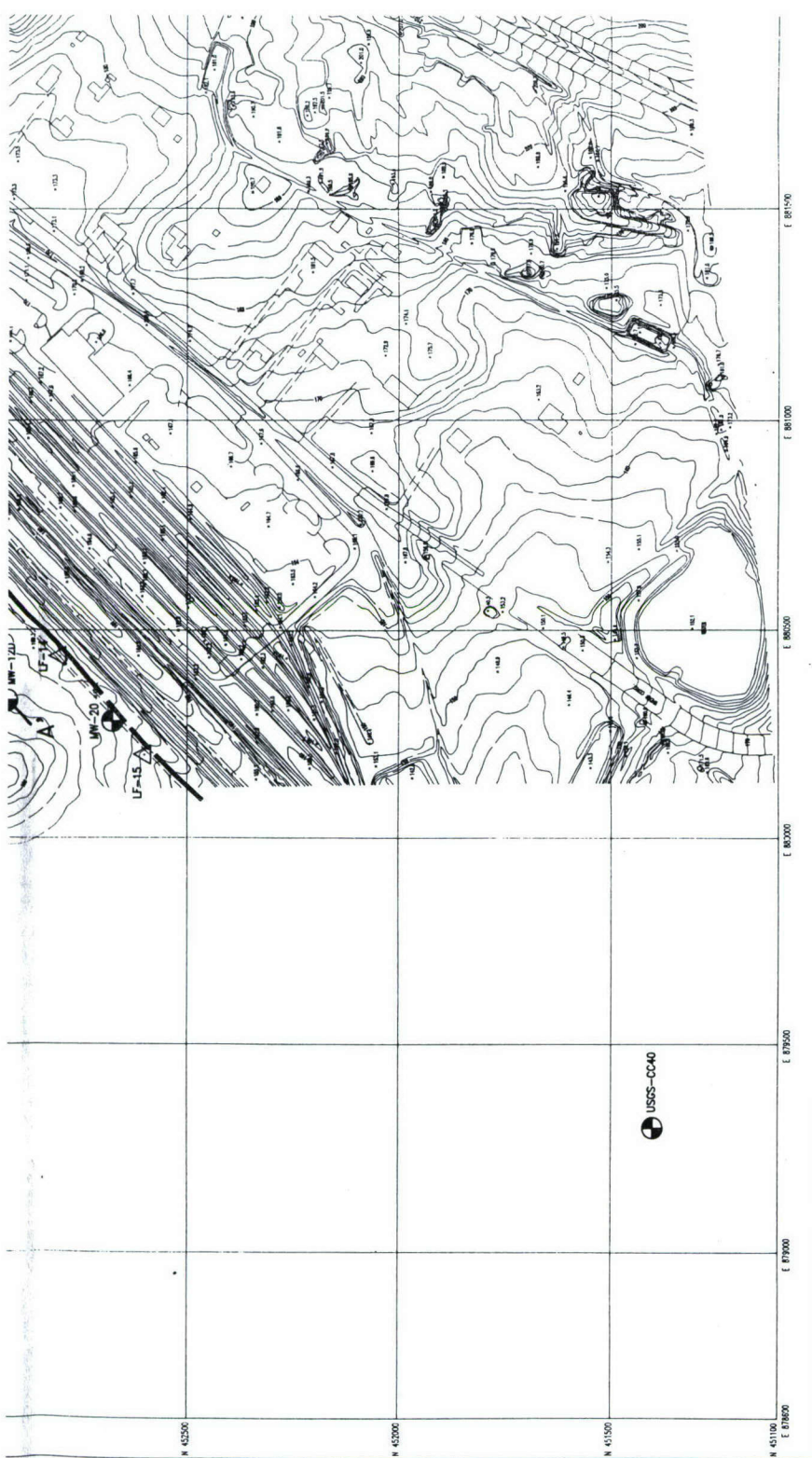
### LEGEND

	MW-1	MONITORING WELL LOCATION
	SS-29	SURFACE SEDIMENT SAMPLE LOCATION
	SS-2 SW-2	SURFACE WATER/SURFACE SEDIMENT SAMPLE LOCATION
	L-1	LEACHATE SAMPLE LOCATION
	LF-14	FIELD SURVEY CONTROL POINT













### NOTES:

- COORDINATES AND ELEVATIONS SHOWN ARE BASED ON THE MARYLAND STATE PLANE COORDINATE SYSTEM AS PROJECTED BY ANNE ARUNDEL COUNTY, DEPARTMENT OF PUBLIC WORKS, USING CONTROL POINTS DPW 157 AND DPW 157 AZ.
- ELEVATIONS ARE BASED ON N.G.V.D. 1929 M.S.L. DATUM.
- TOPOGRAPHY MAPPED FROM AERIAL PHOTOGRAPHY (1"=500'), NOVEMBER, 1990.
- COORDINATES AND ELEVATIONS FOR MONITORING WELLS ARE BASED ON





## LEGEND

	MW-1	MONITORING WELL LOCATION
	SS-29	SURFACE SEDIMENT SAMPLE LOCATION
	SS-2 SW-2	SURFACE WATER/SURFACE SEDIMENT SAMPLE LOCATION
	L-1	LEACHATE SAMPLE LOCATION
	LF-14	FIELD SURVEY CONTROL POINT
	• 78.1	SPOT ELEVATION
	—70—	TOPOGRAPHIC CONTOUR LINE
		APPROXIMATE LANDFILL CELL BOUNDARY
		FORT MEADE RESERVATION BOUNDARY
		APPROXIMATE LIMIT OF PERMITTED LANDFILL AREA
	A—A'	NORTH-SOUTH GEOLOGIC CROSS-SECTION
	B—B'	EAST-WEST GEOLOGIC CROSS-SECTION

## NOTES:

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- TOPOGRAPHY MAPPED FROM AERIAL PHOTOGRAPHY (1"=500'), NOVEMBER, 1990.
- COORDINATES AND ELEVATIONS FOR MONITORING WELLS ARE BASED ON EA FIELD SURVEY (AUG., 1989 AND JUNE, 1990).
- DASHED CONTOUR LINES REPRESENT ESTIMATED CONTOUR INTERVALS BASED ON AERIAL PHOTO INTERPRETATION AND 7.5 M. ODENTON USGS QUADRANGLE MAP.
- 2 FT. CONTOUR INTERVAL.
- SURFACE WATER/SURFACE SEDIMENT COORDINATES AND ELEVATIONS (±2FT.) ARE APPROXIMATE.
- USGS-CC40 COORDINATES AND SURFACE ELEVATIONS ARE APPROXIMATE. THESE WERE OBTAINED FROM 7.5 M. ODENTON USGS QUADRANGLE MAP.
- CELL 1 AND 2 BOUNDARY LINES OUTLINE AREAS WHERE 2-10 FT. LIFTS OF WASTE HAVE BEEN PLACED OVER TRENCH FILL AREA.
- CELL 3 BOUNDARY DEPICTS APPROXIMATE EXTENT OF TRENCH FILL AREA.
- LF-14, LF-15, LF-27, LF-28 - STEEL PINS IN GROUND.  
LF-19-1 AND LF-19-2 - CENTER NAIL IN WOOD STAKE.



REVISIONS			
NO.	DATE	BY	DESCRIPTION

## FORT MEADE REMEDIAL INVESTIGATION FORT MEADE, MARYLAND

### ACTIVE SANITARY LANDFILL SITE MAP



EA ENGINEERING,  
SCIENCE, AND  
TECHNOLOGY, INC.

Loveton Center  
15 Loveton Circle  
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(301) 771-4950

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PROJECT NUMBER  
10559.05

SCALE  
1"=200'













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PLATE  
1




## LEGEND

	MW-1	MONITORING WELL LOCATION
	SS-29	SURFACE SEDIMENT SAMPLE LOCATION
	SS-2 SW-2	SURFACE WATER/SURFACE SEDIMENT SAMPLE LOCATION
	L-1	LEACHATE SAMPLE LOCATION
	LF-14	FIELD SURVEY CONTROL POINT
		SPOT ELEVATION
	70	TOPOGRAPHIC CONTOUR LINE
		APPROXIMATE LANDFILL CELL BOUNDARY
		FORT MEADE RESERVATION BOUNDARY
		APPROXIMATE LIMIT OF PERMITTED LANDFILL AREA
	A'	NORTH-SOUTH GEOLOGIC CROSS-SECTION
	B'	EAST-WEST GEOLOGIC CROSS-SECTION

## NOTES:

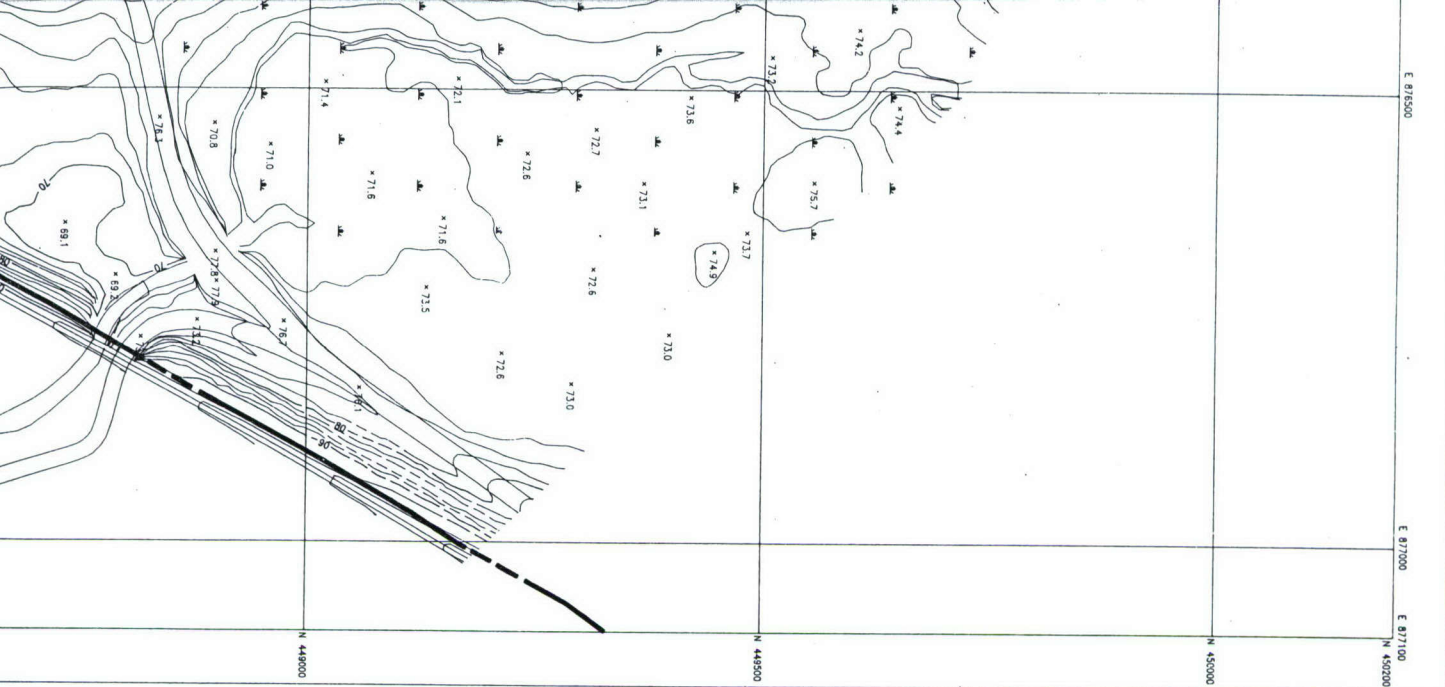
- COORDINATES AND ELEVATIONS SHOWN ARE BASED ON THE MARYLAND STATE PLANE COORDINATE SYSTEM AS PROJECTED BY ANNE ARUNDEL COUNTY, DEPARTMENT OF PUBLIC WORKS, USING CONTROL POINTS DPW 157 AND DPW 157 AZ.
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- CELL 3 BOUNDARY DEPICTS APPROXIMATE EXTENT OF TRENCH FILL AREA.
- LF-14, LF-15, LF-27, LF-28 - STEEL PINS IN GROUND.  
LF-19-1 AND LF-19-2 - CENTER NAIL IN WOOD STAKE.



REVISIONS						FORT MEADE REMEDIAL INVESTIGATION FORT MEADE, MARYLAND	
NO.	DATE	BY	DESCRIPTION			ACTIVE SANITARY LANDFILL SITE MAP	
				DATE 30 SEPTEMBER 91	 <b>EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.</b>  Loveton Center 15 Loveton Circle Sparks, Maryland 21152 (301) 771-4950	PROJECT NUMBER 10559.05	
				DESIGNED BY SAB		SCALE 1" = 200'	
				DRAWN BY MSM/PMS		FILE NAME ASL-E	
				CHECKED BY KWK		DRAWING NUMBER -	
				PROJECT MANAGER SAB		PLATE 1	







MONITORING WELL & SAMPLING LOCATION DATA			
DESIGNATION	NORTHING	EASTING	REFERENCE ELEVATION (FT)
CPD-1	875,817	449,524	115.82
CPD-2	875,573	448,747	65.13
CPD-3S	875,850	448,498	63.54
CPD-3D	875,856	448,510	65.37
CPD-4	876,063	448,465	61.30
CPD-5	875,567	447,379	56.82
SW-6	875,555	447,346	50.0
SS-8	875,555	447,346	50.0

# LEGEND

⊕ CPD-4 Z WELL POINT LOCATION

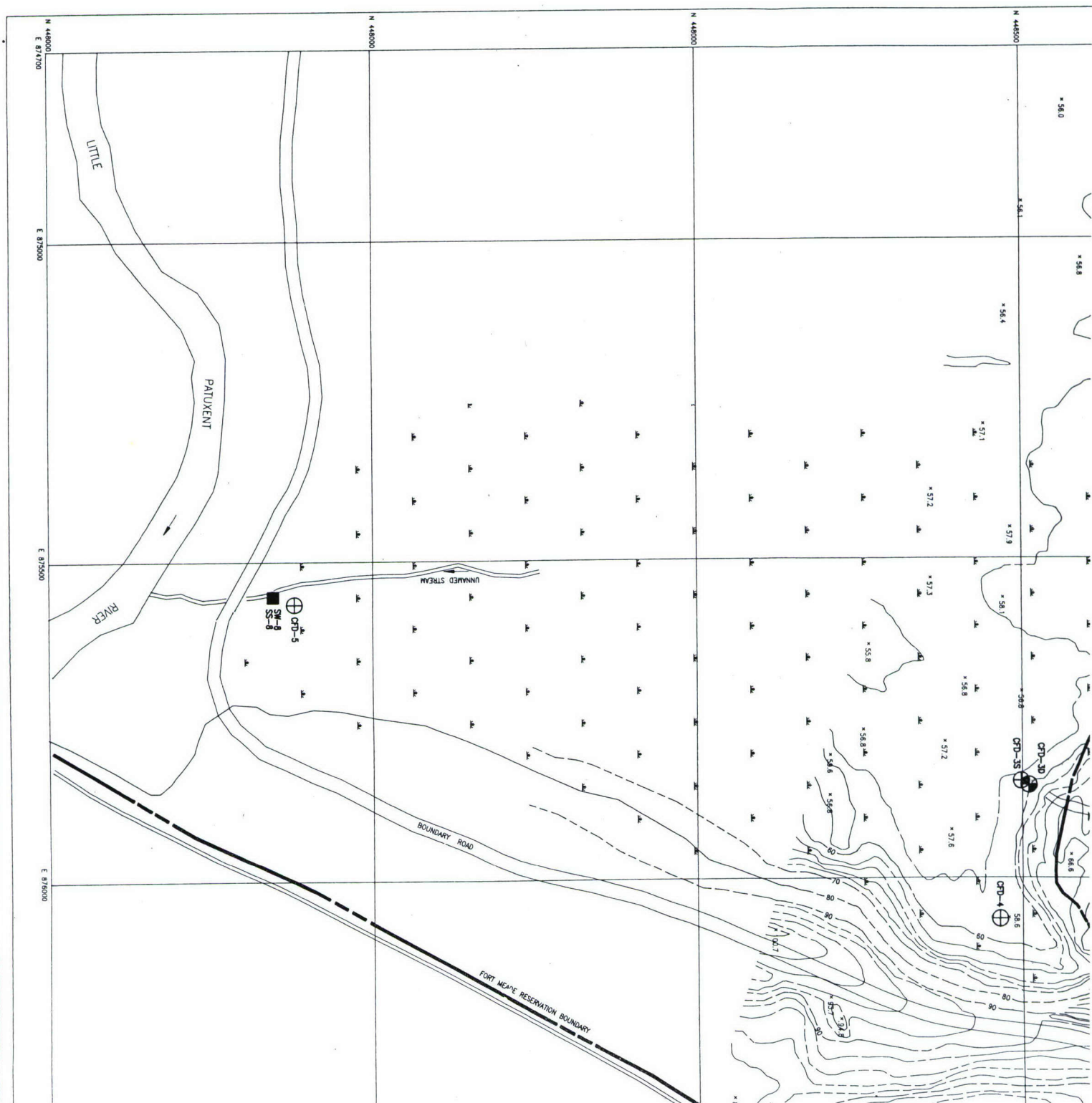
⊕ CPD-1 Z MONITORING WELL LOCATION

■ SW-6 SURFACE WATER/SURFACE SEDIMENT SAMPLE LOCATION

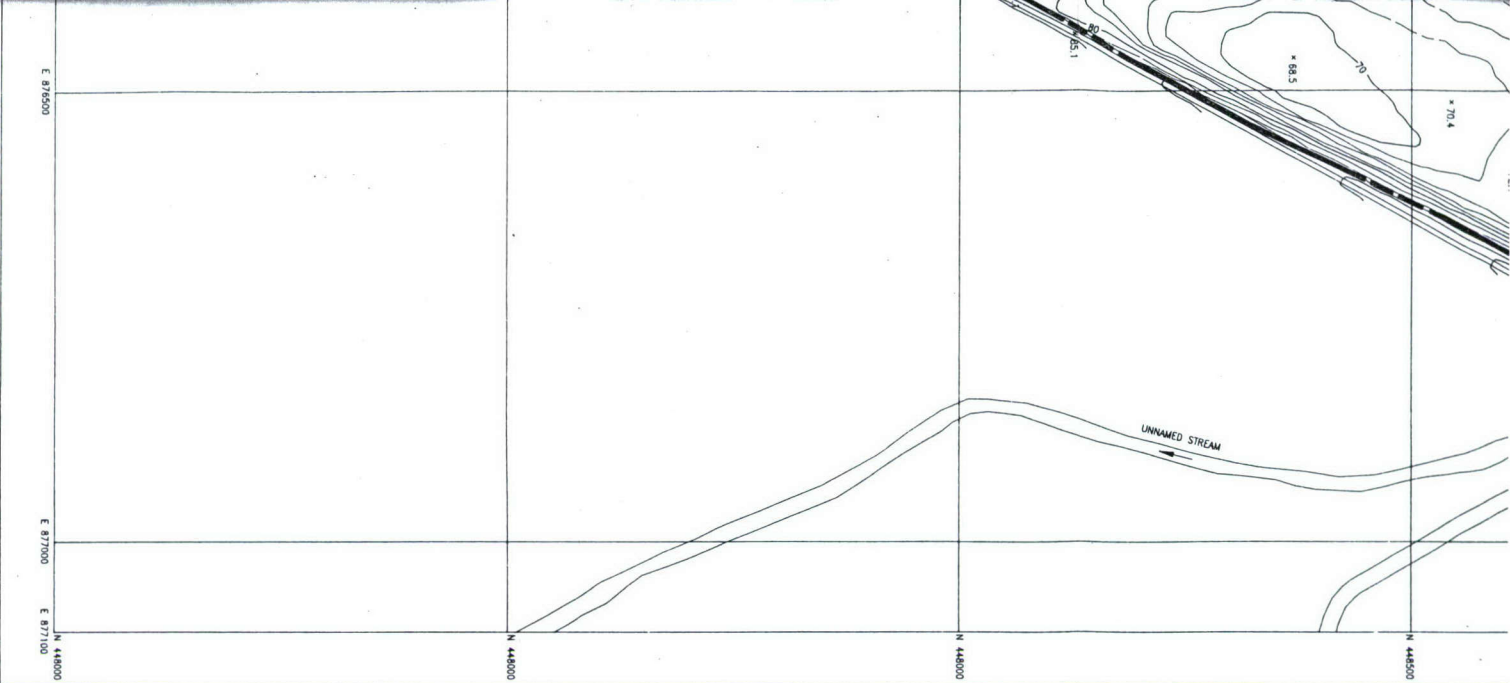
■ SS-8 SPOT ELEVATION

—70— TOPOGRAPHIC CONTOUR LINE

▲ MARSH AREA







NOTES:

1. COORDINATES AND ELEVATIONS SHOWN ARE BASED ON THE MARYLAND STATE PLANE COORDINATE SYSTEM AS PROJECTED BY ANNE ARUNDEL COUNTY, DEPARTMENT OF PUBLIC WORKS.
2. ELEVATIONS ARE BASED ON N.G.V.D. 1929 M.S.L. DATUM.
3. TOPOGRAPHY MAPPED FROM AERIAL PHOTOGRAPHY (1"=500'), NOVEMBER, 1990.
4. COORDINATES AND ELEVATIONS FOR MONITORING WELLS AND WELL POINTS ARE BASED ON EA FIELD SURVEY (AUG. 1989 AND JUNE 90) REFERENCE ELEVATIONS FOR THESE WELLS ARE TOP OF PVC.
5. DASHED CONTOUR LINES REPRESENT ESTIMATED CONTOUR INTERVALS BASED ON AERIAL PHOTO INTERPRETATION AND 7.5 M. OBERTON USSS QUADRANGLE MAP.
6. 2 FT. CONTOUR INTERVAL.
7. SURFACE WATER/SURFACE SEDIMENT COORDINATES AND ELEVATIONS (±2FT.) ARE APPROXIMATE.



REVISIONS			
NO.	DATE	BY	DESCRIPTION

FORT MEADE  
REMEDIAL INVESTIGATION  
FORT MEADE, MARYLAND

CLEAN FILL DUMP SITE MAP



DATE  
30 SEPTEMBER 91  
DESIGNED BY  
SAB  
DRAWN BY  
MSM  
CHECKED BY  
KWK  
PROJECT MANAGER  
SAB

15 Lovelock Circle  
Ft. Meade, MD 21132  
(301) 771-4950

EA ENGINEERING,  
SCIENCE, AND INC.  
TECHNOLOGY,  
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NEW YORK  
DALLAS  
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SAN FRANCISCO

PROJECT NUMBER  
10559.05

SCALE  
1"=100'

FILE NAME  
CFD-E

DRAWING NUMBER  
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PLATE  
2